SOFTWARE QUALITY ASSURANCE OF E-COMMERCE APPLICATION USING ISO 25010 QUALITY MODEL AND ANALYTICAL HIERARCHY PROCESS METHOD (CASE STUDY: BUKALAPAK AND TOKOPEDIA)

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THESIS

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ABSTRACT

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SOFTWARE QUALITY ASSURANCE OF E-COMMERCE APPLICATION USING ISO 25010 QUALITY MODEL AND ANALYTICAL HIERARCHY PROCESS METHOD (CASE STUDY: BUKALAPAK AND TOKOPEDIA).
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(xix+ 165+ appendix)

Measurement of software quality is important for developer to measure the appropriateness of the use of the productivity of resulted software and related to the characteristics and needs of users. In this research will measured the quality of E-Commerce application, specifically in C2C categories, Bukalapak and Tokopedia web application. Bukalapak and Tokopedia are the platforms that bring together sellers and buyers doing online transaction through their sites. The quality of Bukalapak and Tokopedia web application is implicitly visible to the user through the functionality of any features that have operated well. The measurement of both web application is using ISO 25010 Quality Model and Analytical Hierarchy Process (AHP) method on BPMSG AHP Priority Calculator. Based on the test results, the quality of both web application is considered have good quality with value above 80%.

Bibliography (2002-2016)

CURRICULUM VITAE

The author's full name is Amanda Terrena Putri who was born in Manado, August 14th 1993.The educational background started from elementary school in SDN Jatirahayu IV (East Jakarta) graduated on 2005, junior high school in SMPN 259 (East Jakarta) graduated on 2008, and senior high school in SMAN 26 (South Jakarta) on 2011. After graduated from senior high school, then the author continued to take a college in Gunadarma University majoring Information System. In October 2011, the author got Sarjana Magister Program (SarMag Program) with same major as before, Information System and has finished the Undergraduate Degree on 2015 with the research entitled "WEB CLASSIFICATION BASED ON KEYWORD SIMILARITY". At the present, author is finishing the magister program majoring Information System Management concentrate in Business Information System in Gunadarma University.

Jakarta, September 2017

Amanda Terrena Putri, S.Kom

PREFACE

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As ordinary people who make mistakes, Author apologizes for any shortcomings and limitations in drafting this postgraduate thesis.

Finally, author recognizes that this research is far from perfect, due to various limitations that the researcher had. So, author expects criticism and constructive suggestions for improvement in the future.

Hopefully this postgraduate thesis will be useful for all of us.

Jakarta, September 2017

Researcher

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Chapter 1

INTRODUCTION

1.1 Research Background

Internet usage in Indonesia has expanded into various areas of human life, one of them in the business sector. The existence of Electronic Commerce or E-Commerce as one example. E-Commerce is the development of traditional business that does not require a meeting to conduct economic activities such as transacting somewhere. According to Triton (2006), E-Commerce as an electronic commerce where for trade transactions either buy or sell is done through electronic. As the development of the Internet, E-Commerce is also growing. It can be seen based on data from Kementerian Komunikasi dan Informasi (KOMINFO) that estimated E-Commerce transaction in 2016 can reach 25 billion US dollars. The number is up by 40 percent compared to 2015 which is estimated at 13 billion US dollars [5]. The increase can be influenced by several factors, in terms of Internet penetration is increasingly widespread, the current trend and several other reasons that make the people of Indonesia more like buying and selling activities online. This is supported by internet penetration in Indonesia that 50% of the total population of about 132 million Internet users with 63.5% is the E-Commerce user who ever transacted online (Indonesia Association of Internet Service Providers/ APJII.2016). There are several reasons why people in Indonesia conduct transactions online. According to research conducted by idEA some of these reasons relate to the efficiency of time, place, goods, and prices offered [14].

The development of E-Commerce has led to the emergence of diversity of applications that can be categorized in Business to Business (B2B), Business to Consumer (B2C) and Consumer to Consumer (C2C). Some examples of

E-commerce applications such as Lazada, Bukalapak, Tokopedia, OLX, Zalora and others. This diversity does not guarantee that every E-Commerce application has the same quality as one another. This is because the quality of the application is related to the characteristics and needs of users [20].

In this research, Bukalapak and Tokopedia web application that will be tested for measurement of software quality. According to PT. Nusaresearch on 2015, Bukalapak and Tokopedia are part of the top five popular brand in Indonesia. The quality of Bukalapak and Tokopedia web application is implicitly visible to the user through the functionality of any features that have operated well. However, measurement of software quality is important for developer to measure the appropriateness of the use of the productivity of resulted software. This is to find any errors (bugs) that still exist in every E-Commerce application and provide better application performance. Quality measurement is also to determine the best quality between two E-Commerce applications based on the website in accordance with its popularity according to previous research [17].

This research is using ISO 25010 Quality model to measure two dimensions of software quality, are Product Quality dimension and Quality in Use dimension. According to [25] that ISO 25010 is the latest standard and relevant for testing an application that replaces the previous model of ISO 9126 which since 2001 has become the benchmark for software quality analysis. Characteristic and sub characteristic of ISO 25010 Quality model will be tested on Bukalapak and Tokopedia web application with weighting method of Analytic Hierarchy Process (AHP) in BPMSG AHP Priority Calculator tools. AHP method is used because it has a hierarchical structure of ability in generating the most important priority among the existing criteria. Some of characteristics on the quality measurement of both applications will be done through observation and questionnaire.

1.2 Problem Identification

Based on research background above, researcher identify the problems faced by various parties are for developer is how to produce software with good quality based on ISO 25010 Quality Model. The other party is for user, how to know the quality of software used. This research is using two software for the case study, are Bukalapak and Tokopedia web application. Whether the two applications are having good quality in functionality, perfor-

mance, compatibility, usability, reliability, security, maintainability, portability, effectivity, efficiency, satisfaction, freedom from risk and context coverage so that it can really help user activity in online business transaction through web-based application.

1.3 Problem Statement

Problems are identified as statements based on problem identification are as follows:

1. How to determine the weight of characteristic and sub characteristic ISO 25010 Quality Model to measure the quality application using AHP method and Lund A.R. questionnaire?
2. How to find out the characteristics and sub characteristics used to do exactly the assessment of software quality model based on the ISO 25010?
3. How to test the validity and reliability to process the Lund A. R. questionnaire using SPSS?
4. How to perform software quality testing according to the characteristics and sub characteristics used in the ISO 25010 Quality Model?
5. Is the quality of both application compatible with ISO 25010 Quality Model?

1.4 Scope of The Research

Based on the problem identification, the scope of problem are as follows:

1. This research is limited to two E-Commerce web application, Bukalapak and Tokopedia web application.
2. Measurement of application quality is limited to www.bukalapak.com (Bukalapak) and www.tokopedia.com (Tokopedia) which is not directly on mobile website applications.
3. Software quality measurement using ISO 25010 Quality Model.
4. The population used is Bukalapak and Tokopedia web application users.

5. Questionnaires filled by 400 respondents using Purposive Sampling Technique

6. Sample is a user of E-Commerce web application that have educational background of IT and domiciled in Jakarta, Bogor, Depok, Tangerang and Bekasi (Jabodetabek).

1.5 Research Objective

This research aims to assess the quality of Bukalapak and Tokopedia web application using ISO 25010 Quality Model. In addition to ensure that Bukalapak and Tokopedia web application have met international quality standards based on international standardization and see what characteristics are influential in the application refers to ISO 25010 standard, so it is expected to provide information and guidance for E-Commerce application developers about the characteristics that must be considered in the development of E-Commerce application.

1.6 Research Benefits

This research is expected to be useful for all parties related both theoretical and practical benefits. The theoretical benefits that can be derived from this research are for the development of science. With this research insight on software quality assurance based on ISO 25010 standard, especially in E-commerce applications, can be more extensive. The practical usefulness that is expected to be useful for the application developers and users of this research are as follows:

1. For academics, this research can be used as a reference for measuring the quality of application, especially E-Commerce web application.

2. For researchers, this research can contribute to the development of quality measurement of E-Commerce web application as literature in Indonesia.

3. For developers, this research is expected to provide knowledge for developer on how to test the quality of produced E-Commerce web application. Quality measurement of Bukalapak and Tokopedia web application can provide feedback information on the user's responses.

Feedback is a material improvement in the development of better performance than ever. It is also expected to be a reference for developers about what characteristics are the benchmark of the quality E-Commerce application.

4. For users or general, this research is generally expected to provide information about factors that determine the quality of E-Commerce application is good or still need improvement. So that the later knowledge can be a consideration for users in choosing the E-Commerce application more wisely and according to their needs.

Chapter 2

LITERATURE REVIEW

2.1 The Development of Electronic Commerce

Electronic commerce has existed for over 40 years, originating from the electronic transmission of messages during the Berlin airlift in 1948. From this, electronic data interchange (EDI) was the next stage of e-commerce development. In the 1960s a cooperative effort between industry groups produced a first attempt at common electronic data formats. The formats, however, were only for purchasing, transportation and finance data, and were used primarily for intra-industry transactions. It was not until the late 1970s that work began for national Electronic Data Interchange (EDI) standards, which developed well into the early 1990s. EDI is the electronic transfer of a standardized business transaction between a sender and receiver computer, over some kind of private network or value added network (VAN). Both sides would have to have the same application software and the data would be exchanged in an extremely rigorous format.

Electronic commerce or known as business activities through online with helping of technology. E-commerce is envolving as technology advances to equalize traditional business activity. Table 2.1. Below is comparison of traditional commerce and E-Commerce.

Table 2.1: Comparison of Traditional Commerce and E-Commerce

Key Elements	E-Commerce	Traditional Commerce
Value Creation	Information	Product/ services
Strategy	Sense and respond, simple rules	Classical
Competitive Edge	Speed	Quality/ cost
Competitive Force	Low barriers of entry	Power of suppliers
	Power of customers	Product Substitution
Resource Focus	Demand size	Supply size
Customer Interface	Screen to face	Face to face
Communication	Technology-mediated channels	Personal
Accessibility	24 x 7	Limited time
Customer Interaction	Self service	Seller influenced
Consumer Behavior	Personalization one to one marketing	Standardization mass/ one-way marketing
Promotion	Word of mouth	Merchandising
Product	Commodity	Perishables, feel and touch

2.2 E-Commerce Application

The diversity of E-Commerce applications can now be categorized into three categories: Business to Business (B2B), Business to Consumer (B2C) and Consumer to Consumer (C2C). Based on research conducted by Nusaresearch Omnibus (Popular Brand Index) [17] there are five top of the E-Commerce website that is Lazada, Tokopedia, OLX, Bukalapak and Zalora (Nusaresearch, 2014). In this study researcher will conduct research on both sites E-Commerce namely Bukalapak (www.bukalapak.com) and Tokopedia (www.tokopedia.com).

2.2.1 Bukalapak

Bukalapak is one of the platform that bring together sellers and buyers online through the website www.bukalapak.com and launched on January 10, 2010. Bukapalak is categorized as C2C because consumers directly sell goods that are marketed to other consumers. Bukalapak is under the auspices of PT. Bukalapak.Com. Bukalapak is ranked 12th in Indonesia and ranked 571th in the world as the C2C marketplace [18].

Figure 2.1. Below is the logo of Bukalapak web application.

Figure 2.1: Logo of Bukalapak [27]

Since the application is a C2C application so that the application acts as a media liaison (platform) in marketing and buying goods between the seller (individual or company). Nevertheless, Bukalapak web application does not provide a separate custom application for both the seller and the buyer. Just by accessing the site, the user can act as a seller and doubles as a buyer. The features provided through Bukalapak web application are as Table 2.2. Below.

Table 2.2: Features of Bukalapak (www.bukalapak.com)

Feature	Description
Filter	Refine search of goods according to existing parameter (relevance, latest, cheapest, most expensive, best sellers)
Sale item	View discount item
Transaction	Check transaction status for buyer without logi
Installment	Installment payment method for the account owner
Feedback	Feedback to product
Help	Question and answer
Chat	Chatting between seller and buyer
Sell Product	Sell product by upload photo (must have an account)
Return of Product	Return of goods if the condition of the product is damaged
Item Replacement	Finding the same item in accordance with the product that want to byt when product is rejected/ ignored by seller
Premium Account	Provide statistic of sales to see the right market trends to improve sales transaction
MyLapak	Product management of seller
BukaDompet	Balance against sales by seller
Push	Promote product to be the first position on the product list page
BL Widget	Promote selling to other websites
Subsribe	View and add subscribed lists of subscribers
Search & Sorting Transaction	Find and grouping transaction status
Print Delivery Address	Print delivery address of buyer
Careers	Provide available job vacancies

2.2.2 Tokopedia

Tokopedia is an online business application launched on August 17, 2009. Tokopedia is under the auspices of PT. Tokopedia founded by William Tanuwijaya and Leontinus Alpha Edison on February 6, 2009 with the site www.tokopedia.com. Tokopedia application include the C2C application category that allows users who act as sellers to be able to design online stores and buyers can transact anytime and anywhere. Tokopedia application is a platform that helps the occurrence of such transactions although in the end the buyer can interact directly with the seller.

Figure 2.2. Below is the logo of Tokopedia web application.

Figure 2.2: Logo of Tokopedia [28]

Table 2.3. Below is features of Tokopedia web application through www.tokopedia.com.

Table 2.3: Features of Tokopedia (www.tokopedia.com)

Feature	Description
Filter	Filter searching of goods according to existing parameters (delivery support, condition, preorder)
Hot List	Display some types of products that are becoming trend at Tokopedia
Wishlist	Marking the product that want to buy at a later
Review	Provide review of product
Gold Merchant	Manage stores
Accept orders at once	Respond to all buyer orders
User Managemenr	Manage store by admin
Stock Management	See the rest of the products in store
Careers	Provide available job vacancies

2.3 Software Quality Assurance

According to IEEE Glossary, Software Quality Assurance (SQA) is a planned and systematic pattern of all actions necessary to provide adequate confidence that an item or product conforms to established technical requirements. Software Quality Assurance (SQA) is also a set of evaluation activities designed to develop or produce a product. SQA is based on the planning and

implementation of various measures which are integrated into all the stages of the software development process. This is done to support the user confidence that the software product will meet all the technical requirements. Despite its emphasis on planning and systematic implementation, SQA scope doesn't include maintenance, timetable, and budget issues. The expanded SQA definition in accordance with the standards basic concept of the existing quality models [9].

The objectives of SQA activities refer to the functional, managerial and economic aspects of software development and software maintenance. It is performed to prevent, detect, and correct the cause of the error. These objectives can be seen from the aspects as follows: [9]

1. Software Development (Process-Oriented):

   (a) Assuring an acceptable level of confidence that the software will conform to functional technical requirements.

   (b) Assuring an acceptable level of confidence that the software will conform to managerial scheduling and budgetary requirements.

   (c) Initiating and managing of activities for the improvement and greater efficiency of software development and SQA activities. This means improving the prospects that the functional and managerial requirements will be achieved while reducing the costs of carrying out the software development and SQA activities.

2. Software Maintenance (Product-Oriented):

   (a) Assuring with an acceptable level of confidence that the software maintenance activities will conform to the functional technical requirements.

   (b) Assuring with an acceptable level of confidence that the software maintenance activities will conform to managerial scheduling and budgetary requirements.

   (c) Initiating and managing activities to improve and increase the efficiency of software maintenance and SQA activities. This involves improving the prospects of achieving functional and managerial requirements while reducing costs. Guarantee with an acceptable level of confidence that software maintenance activities will be in accordance with functional technical requirements.

2.4 Quality Models

Software Quality Assurance (SQA) has some choice models that can be used to measure software quality assurance. Generally, software quality has the identification as follows: [16]

1. Conformance to Specification: Quality is defined as matter of products and services whose measurable characteristics satisfy a fixed specification.

2. Meeting Customer Needs: Quality of identified independent of any measurable characteristics. It's defined as the products or services capability to meet customer expectations explicitly or not.

Quality model that has international standards can be used as a reliable reference for the process of measuring the software quality is done. Quality model of international standards and the most commonly used among others McCall's Quality Model (1977), Boehm's Quality Model (1978), and ISO 9126's Quality Model (2001) [16].

2.4.1 McCall's Quality Model (1977)

Founder of famous quality models that are still current quality models is a model of quality presented by Jim McCall (also known as the General Electrics Model of 1977). McCall's Quality Model attempts to bridge the gap between users and developers by focusing on a number of software quality factor that reflect both the user views and developer priorities. This model is derived from the US military (developed for the US Air Force, promoted within DoD) and aimed towards the system developers and system development process [16].

McCall's Quality Model has three major perspectives to define and identify the quality of software products, including product revision, product transition, and product operations. Product revision is the ability to undergo changes, product transition is the adaptability to new environments, and product operating is the ability to operate the product. Product revision includes maintainability, flexibility and testability. Product transition is all about portability, reusability, and interoperability. Meanwhile, the quality of

product operations related to correctness, reliability, efficiency, integrity, and usability [16].

On McCall's Quality Model, as shown in Figure 2.3, three types of quality characteristics (major perspectives) specified in a hierarchy of factors, criteria, and metrics as follows [16]:

1. 11 Factors (to specify): Describing the external view of the software, as seen by the users.

2. 23 Quality Criteria (to build): Describing the internal view of the software, as seen by the developer.

3. Metrics (to control): Defined and used to provide the scale and method for measurement.

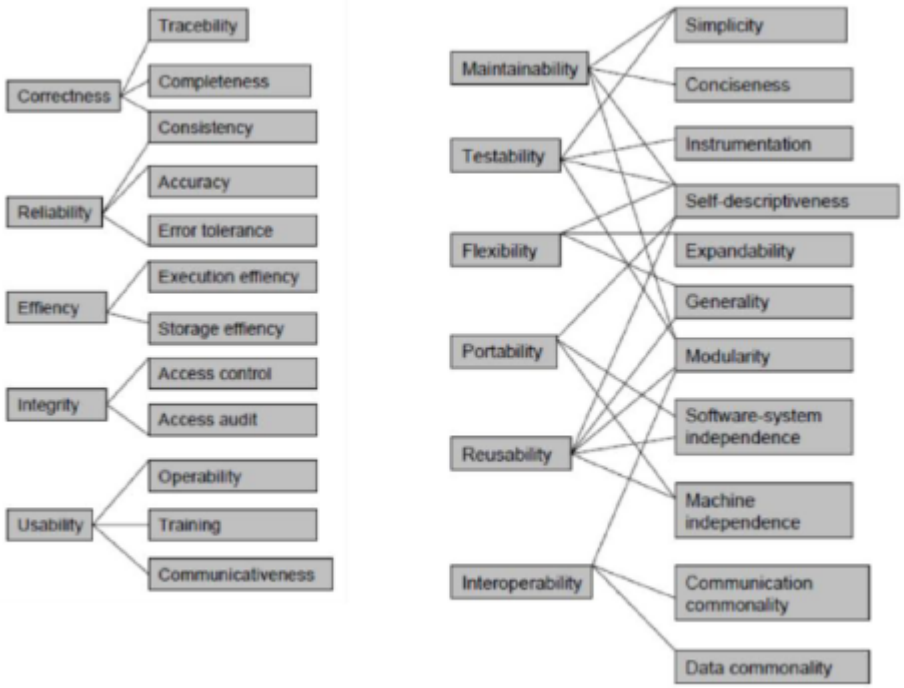


Figure 2.3: McCall's Quality Model

The quality model of McCall in Figure 2.3. Above explained that the hierarchy of 11 quality factors on the left hand side and 23 quality criteria on the right hand side. The idea behind McCall's Quality Model is quality factor should give an idea software quality completely [16].

2.4.2 Boehm's Quality Model (1978)

Boehm's Quality Model is a quality model presented by Barry W. Boehm in 1978 to discuss the contemporary shortcomings of models that automatically and quantitatively evaluate the quality of software. Boehm's Quality Model is similar to McCall's Quality Model in that it also presents structured hierarchy. Consequently, this model tries to determine the software quality is based on a set of attributes and metrics[16].

Figure 2.4. Below is Boehm's Quality Model.

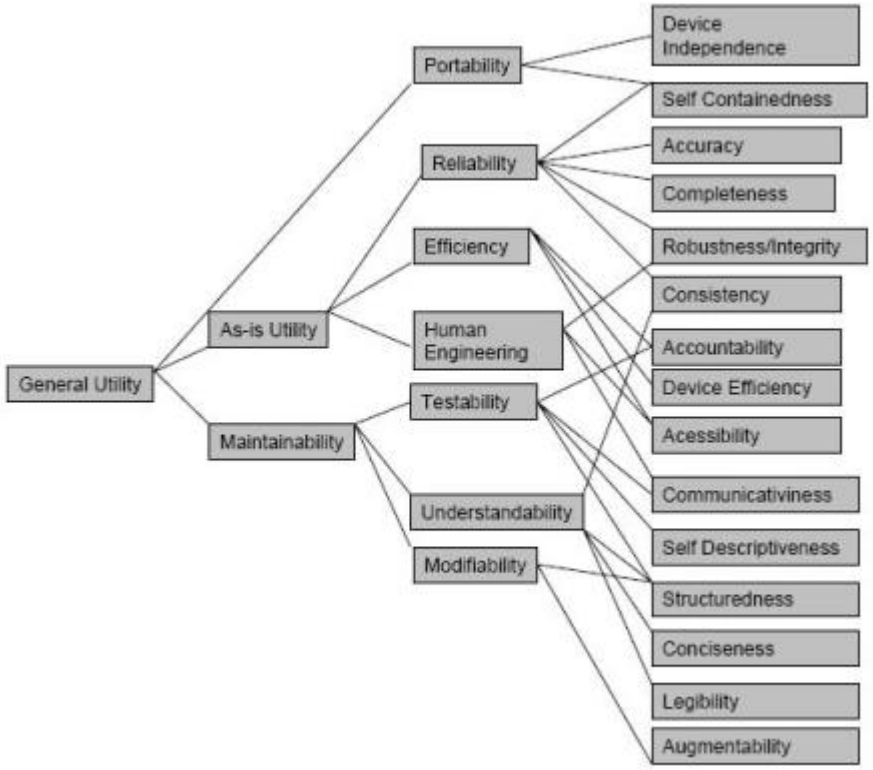


Figure 2.4: Boehm's Quality Model

The model shown in Figure 2.4 has a characteristic level from high to low-level characteristic. The high-level characteristics represent basic high-level requirements of the actual use to evaluate the software quality. The high-level characteristics address three main questions that are usually asked by a buyer of the software, such as [16]:

1. As-is Utility: How well (easily, reliably, efficiently) can I use it as-is?

2. Maintainability: How easy is it to understand, modify, and retest?

3. Portability: Can I still use it if I change my environment? Mid-level characteristics have seven Boehm quality factors representing the expected quality of a software system. Seventh Boehm quality factor is as follows [16]:

   (a) Portability (General utility characteristics): Code possesses the characteristic portability to the extent that it can be operated easily and well on the computer configurations other than its current one.

   (b) Reliability (As-is utility characteristics): Code possesses the characteristic reliability to the extent that it can be expected to perform its functions.

   (c) Efficiency (As-is utility characteristics): Code possesses the characteristic efficiency to the extent that it fulfills its purpose without waste of resources.

   (d) Usability (As-is utility characteristics, Human engineering): Code possesses the characteristic usability to the extent that it is reliable, efficient, and human-engineered.

   (e) Testability (Maintainability characteristics): Code possesses the characteristic testability to the extent that it facilitates the establishment of verification criteria and supports the performance evaluation.

   (f) Understandability (Maintainability characteristics): Code possesses the characteristic understandability to the extent that its purpose is clear to inspectors.

   (g) Flexibility (Maintainability characteristics, Modifiability): Code possesses the characteristic modifiability to the extent that it facilitates the incorporation of changes, once the nature of the desired changes has been determined.

The lowest level structure of the hierarchy in Boehm's Quality Model is the primitive characteristics metrics hierarchy. Primitive characteristics provide the foundation for defining qualities metrics which was one of the goals when Boehm constructed his quality model. Though Boehm and McCall have similarities, Boehm's Quality Model is more focused on the models effort on software maintenance cost-effectiveness [16].

2.4.3 ISO 9126's Quality Model (2001)

International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) has established ISO/ IEC standards related to software quality. ISO 9000 is the first time that has three guidelines for implementing ISO 9001 standards relating to quality assurance processes. This process is done for the development, supply, installation, and maintenance of computer software. Then, the standard ISO / IEC 9126 is set for the quality of software products and standard ISO / IEC 14598 for the evaluation of software products. Other standards that can be used in conjunction with ISO / IEC 9126 and ISO / IEC 14598 are [4]:

1. ISO/IEC 12119 - Requirements for the quality of software package.
2. ISO/IEC 12207 - Software life cycle process.
3. ISO/IEC 14143 - Software measurement.
4. ISO/IEC 15271 - Guide for ISO / IEC 12207.
5. ISO/IEC 15504 - Assessment process software (also known as SPICE - Software Process Improvement for Capability Determination).
6. ISO/IEC 15939 - Process measurement software.

Standard of ISO / IEC 9126 makes a distinction between internal quality and external quality. This model categorizes software quality attributes into characteristics. Attributes that can be measured during the development process is referred to as internal. Meanwhile, the external behavior can be measured during the testing process and the quality of the user view [4]. ISO/ IEC 9126 consists of four parts which include ISO 9126-1 Quality Model, ISO 9126-2 External Metrics, ISO 9126-3 Internal Metrics, and ISO 9126-4 Quality in Use Metrics [16].

ISO 9126-1's Quality Model defined by the common characteristics of software, which is further refined into sub characteristics, which in turn is decomposed into attributes and generate a multilevel hierarchy. The main idea behind this standard is the definition of quality model and its use as a framework software evaluation. ISO 9126-1 Quality Model of 2001 version has six characteristics and 27 sub characteristics are described in Table 2.4. Below [4].

Table 2.4: ISO 9126-1 Quality Model [P. Botella, 2004]

Feature	Description
Functionality	Suitability Accuracy Interoperability Security Functionality Compliance
Reliability	Maturity Fault Tolerance Recoverability Reliability Compliance
Usability	Understandability Learnability Operability Attractiveness Usability Compliance
Efficiency	Time Behaviour Resource Utilization Efficiency Compliance
Maintainability	Analysability Changeability Stability Testability Maintainability Compliance
Portability	Adaptability Installability Coexistence Replaceability Portability Compliance

In the version 2001, there are additional sub characteristics Compliance at every ISO 9126-1 Quality Model characteristics. The standard of ISO 9126-1's Quality Model characteristics are explained as follows:

1. Functionality: The ability of software to provide functionality according to user requirements when used in certain conditions.

2. Reliability: The ability of the software to maintain the performance level when used in certain conditions.

3. Usability: The ability of software related to the use of software that is done by the user.

4. Efficiency: The ability of the software to provide an appropriate performance level and the amount of resources used when the software is

run.

5. Maintainability: The ability of the software that is related to the effort required to be modified or changed.

6. Portability: The ability of the software to be sent to a different environment or one environment to another.

2.4.4 ISO 25010 Quality Model (2010)

ISO / IEC 25010: 2010 (ISO 25010) is part of a series known as Software Quality Requirements and Evaluation (SQuaRE), defines system quality as "the degree to which the system satisfies the stated and implied needs of its various stakeholders, thus provides value "[7].

ISO 25010 Quality model is the development of ISO 9126. ISO 25010 has two main dimensions, are Quality in Use (QinU) and Product Quality. QinU defines characteristic related to human interaction with system while Product Quality defines basic characteristic of product. QinU defines as “capability of a software product to influence users’ effectiveness, productivity, safety and satisfaction to satisfy their actual needs when using the software product to achieve their goals in a specified context of use” [6]. QinU model consists of five characteristics are effecticeness, efficiency, satisfaction, freedom from risk and context coverage. Figure 2.5. Below describes characteristic and sub characteristic of QinU dimension [7].

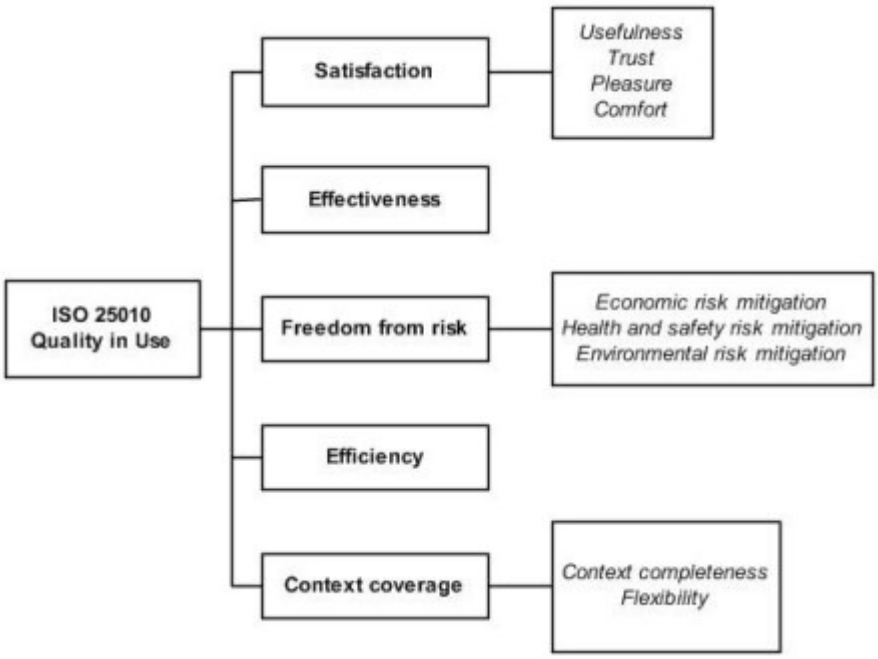


Figure 2.5: ISO 25010 Quality in Use

Definition of each characteristic and sub characteritis can be seen on following Table 2.5. Below.

Table 2.5: Quality in Use Characteristics and Sub Characteristics

Characteristic	Definition	Sub Characteristic	Definition
Effectiveness	Accuracy and completeness with which users achieve specified goals (ISO 9241-11).		
Efficiency	Resources expended in relation to the accuracy and completeness with which users achieve goals (ISO 9241-11).		
Satisfaction	Degree to which user needs are satisfied when a product or system is used in a specified context of use.	Usefulness	Degree to which a user is satisfied with their perceived results of use and the consequences of use.
		Trust	Degree to which a user or other stakeholder has confidence that a product or system will behave as intended.
		Pleasure	Degree to which a user obtains pleasure from fulfilling their personal needs.
		Comfort	Degree to which the user is satisfied with physical comfort.
Freedom from Risk	Degree to which a product or system mitigates the potential risk to economic status, human life, health, or the environment.	Economic Risk Mitigation	Degree to which a product or system mitigates the potential risk to financial status, efficient operation, commercial property, reputation or other resources in the intended contexts of use.
		Healthy and Safety Risk Mitigation	Degree to which a product or system mitigates the potential risk to people in the intended contexts of use.
		Environmental Risk Mitigation	Degree to which a product or system mitigates the potential risk to property or the environment in the intended contexts of use.
Context Coverage	Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in both specified contexts of use and in contexts beyond those initially explicitly identified.	Context Completeness	Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in all the specified contexts of use.
		Flexibility	Degree to which a product or system can be used with effectiveness, efficiency, satisfaction in contexts beyond those initially specified in the requirements.

Product Quality dimension consists of eight quality characteristics, namely Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability and Portability. Figure 2.6. Below describes the characteristics and sub characteristics of the Product Quality dimension.

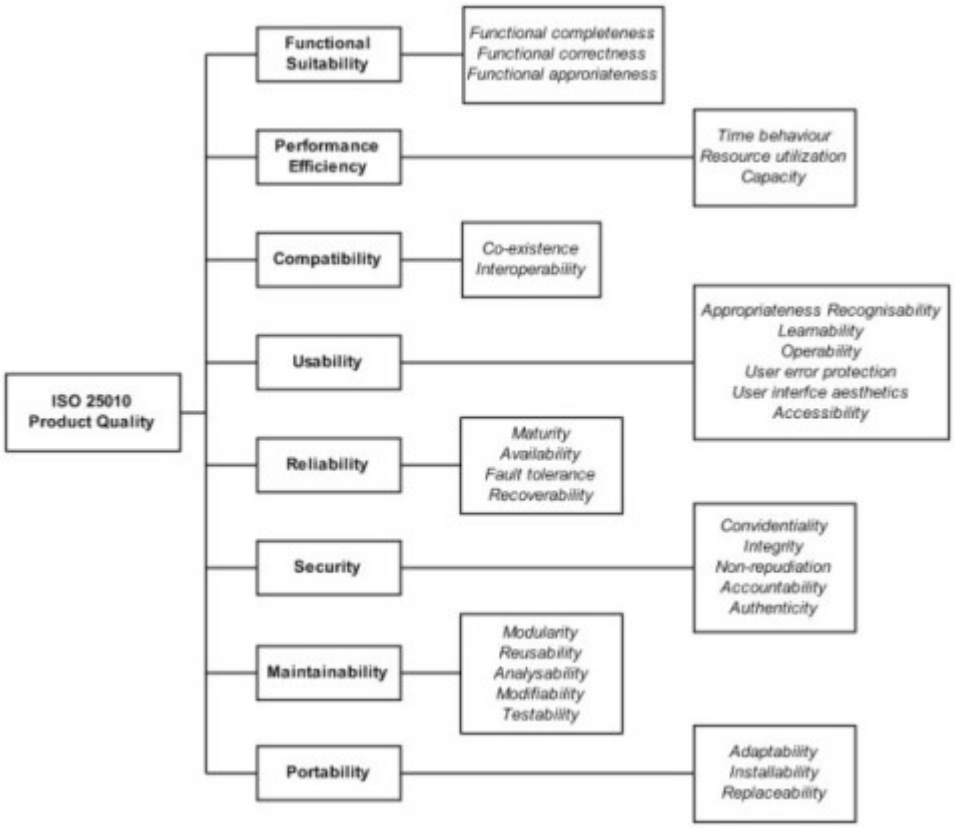


Figure 2.6: ISO 25010 Product Quality

Definitions of each sub characteristic can be seen in the following Table 2.6. Below.

Table 2.6: Product Quality Sub Characteristics

Characteristic	Definition	Sub Characteristic	Definition
Functional Suitability	Degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions.	Functional Completeness	Degree to which the set of functions covers all the specified tasks and user objectives.
		Functional Correctness	Degree to which the functions provides the correct results with the

			needed degree of precision.
		Functional Appropriateness	Degree to which the functions facilitate the accomplishment of specified tasks and objectives.
Performance Efficiency	Represents the performance relative to the amount of resources used under stated conditions.	Time Behavior	Degree to which the response and processing times and throughput rates of a product or system, when performing its performing its functions, meet requirements.
		Resource Utilization	Degree to which the amounts and functions, meet requirements.
		Capacity	Degree to which the maximum limits of the product or system, parameter meet requirements.
Compatibility	Degree to which a product, system or component can exchange information with other products, systems or components, and/ or perform its required functions, while sharing the same hardware or software environment.	Co-Existence	Degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product.
		Interoperabillity	Degree to which two or more systems, products information that has been exchanged.
Usability	Degree to which a product or system	Appropriate Recognisability	Degree to which users can recognize

	can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.		whether a product or system is appropriate for their needs.
		Learnability	Degree to which a product or system enables the user to learn how to use it with effectiveness, efficiency emergency situations.
		Operability	Degree to which a product or system is easy to operate, control and appropriate to use.
		User Error Protection	Degree to which a product or system protects users against making errors.
		User Interface Aesthetics	Degree to which a user interface enables pleasing and satisfying interaction for the user.
		Accessibillity	Degree to which a product or system can be used by people with the capabilities to achieve a specified goal in a specified

			context of use.
Reliability	Degree to which a system, product or component performs specified functions under specified conditions for a specified period of time.	Maturity	Degree to which a system, product or component meets needs for reliability under normal operation.
		Availabillity	Degree to which a product or system is operational and accessible when required for use.
		Fault Tolerance	Degree to which a system, product or component operates as intended despite the presence of hardware or software faults.
		Recoverabillity	Degree to which, in the event of an interruption or a failure, a product directly affected and re-establish the desired state of the system.
Security	Degree to which a product or system protects information and data so systems have the degree of data access	Confidentiality	Degree to which the prototype ensures that data are accessible only to those authorized to have.
		Integrity	Degree to which

	appropriate to their types and levels of authorization.		a system, product computer programs or data.
		Non-Repudiation	Degree to which actions or events cannot be repudiated later.
		Accountabillity	Degree to which the actions of an entity can be traced uniquely to the entity.
		Authenticity	Degree to which the identity of a subject or resource can be proved to be the one claimed.
Maintainability	Degree of effectiveness and efficiency with which a product or system can be modified to imporve it, correct it or adapt it to changes in environment, and in requirement.	Modularity	Degree to which a system or computer program is composed of to one component has minimal impact on other components.
		Reusabillity	Degree to which an asset can be used in more than one system, or in building other assets.
		Analyzability	Degree of effectiveness and efficiency with which it is possible to assess the impact on a product or

			system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified.
		Modifiabillity	Degree to which a product or system can be effectively defects or degrading existing product quality.
		Testability	Degree of effectiveness and efficiency with which test criteria can be established for a system, component and tests can be performed to determine whether those criteria have been met.
Portability	Degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or	Adaptability	Degree to which a product or system can effectively and efficiently hardware, software or other operational or usage environments.
		Installabillity	Degree of effectiveness and efficiency in uninstalled in a

	usage environment to another.		specified environment.
		Replaceability	Degree to which a product same environment.

2.4.5 Comparison of ISO Quality Model

Comparison of Quality Model McCall, Boehm, ISO 9126 and ISO 25010 based on its characteristic can be seen on the following Table 2.7. Below.

Table 2.7: Comparison of ISO Quality Model

Quality Factor	McCall (1977)	Boehm (1978)	ISO 9126 (2000)	ISO 25010 (2010)
Accuracy			X	X
Adaptability				X
Analyzability			X	X
Attractiveness			X	X
Changeability			X	X
Correctness	X			X
Efficiency	X	X	X	X
Flexibility	X			
Functionality			X	X
Human Engineering		X		
Installability			X	X
Integrity	X			X
Interoperability	X			X
Maintainability	X		X	X
Maturity			X	X
Modifiability				X
Operability			X	X
Performance			X	X
Portability	X	X	X	X
Reliability	X	X	X	X
Resource Utilization			X	X
Reusability	X			X
Stability			X	X
Suitability			X	X
Supportability			X	X
Testability	X	X	X	X
Transferability				X
Understandability		X	X	X
Usability	X		X	X

Based on Table 2.7. Above, ISO 25010 quality model has the most complete characteristics compared to other quality models because it includes

26 of the 28 features available. From that comparison, the characteristics of Efficiency, Portability and Reliability are characteristics that appear in all quality models. The ISO 25010 quality model is a development of the ISO 9126 quality model, so it can be seen in Table 2.7. Above that ISO 9126 quality model has almost complete characteristics as in ISO 25010 quality model. According to the research [4] ISO 9126 has some limitations due to its generic nature. Some of the concepts presented by ISO 9126 need to be refined before they are actually implemented in a project. In addition, the elements of the software metrics are unclear when defining standards [8].

New characteristics have been included in ISO 25010 quality model such as security and compatibility. These two characteristics are not presented in ISO 9126. Characteristic hierarchies and sub characteristics are reset in order to improve understanding of related concepts. This is done to overcome the limitations of ISO 9126 in relation to the abstract nature, incompleteness and ambiguity as described by the researchers [1]. One of the other reasons that ISO 9126 model is not relevant to be standard in software testing because ICT changes are very fast and very different from a decade ago. Evolution in the world of ICT such as greater memory, better display to faster processor enables the development of new application systems that also require different qualities such as by using the ISO 25010 quality model [25]. Based on data from research and comparison of the quality model, this research uses ISO 25010 quality model to measure the quality of Bukalapak and Tokopedia web application.

2.5 Weighting Determination Method

The weights are usually determined to obtain a sequence of criteria ranging from the level of the most prioritized to the lowest level. Weighting is done to facilitate decision making using existing methods. Of the many weighting methods, one of which is Analytical Hierarchy Process (AHP).

2.5.1 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a decision-making model developed by Thomas L. Saaty in 1980. This model has been successfully applied to a variety of decision-making situations. AHP does not only act as the sole decision maker to choose the most suitable alternative, but expanded also to group decision making. AHP will unite decision maker's preference rating

for each decision alternative under each criterion in the decision hierarchy. Steps to obtain a decision in AHP are as follows [29]:

1. Decompose the problem in the hierarchical structure decision, including all the criteria, sub-criteria, and decision alternatives.

2. Conduct pairwise comparisons of all decision alternatives under each criterion based on preference rating Saaty scale described in Table 2.8. Below.

Table 2.8: Intensity of Pairwise Comparison AHP [G. Xiao, 2010]

Intensity	Definition	Explanation
1	Equal Importance	Two elements contribute equally to the objective.
3	Moderate Importance	Experience and judgement slightly favor one element over another.
5	Strong Importance	Experience and judgement strongly favor one element over another.
7	Very Strong Importance	Accuracy One element is favored very strongly over another. Its dominance is demonstrated in practice.
9	Extreme Importance	The evidence favoring one element over another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values.	
Reverse	If factor i has one of the above numbers assigned to it when compared to factor j, then j has the reciprocal value when compare to i.	

3. Derive the weight of local priority using the eigenvector method or other approximation methods.

4. Synthesize the weight of local priority to produce the overall weight of preference for each decision alternative.

5. Check the inconsistency level of the decision maker's pairwise comparisons. If the level of inconsistency is unacceptable, the decision makers should revise the pairwise comparisons (see Step 2).

2.6 Statistical Product and Service Solutions (SPSS)

SPSS Statistics is a comprehensive system for analyzing data. SPSS Statistics can take data from almost any type of file. The data is used to

generate tabulated reports, charts and plots of distribution and trends, descriptive statistics, along complex statistical analysis. SPSS Statistics ownership is held by International Business Machines (IBM) Corporation. There are several types of window that is commonly used in all versions of SPSS Statistics, including [13]:

1. **Data Editor.** Data Editor displays the contents of the data file. Users can create new data files or modify existing data files in the Data Editor.

2. **Viewer.** All statistical results, tables, and charts are displayed in the Viewer. Users can edit the output and save it for later use. Viewer window opens automatically the first-time users run a procedure that generates output.

3. **Pivot Table Editor.** Output that is displayed in pivot tables can be modified in various ways using the Pivot Table Editor. Users can edit text, swap data in rows and columns, add color, create multidimensional tables, and selectively hide and show results.

4. **Chart Editor**. Users can modify high-resolution charts and plots in the chart window. Users can change the colors, select type fonts or sizes are different, switch the horizontal and vertical axes, rotate 3-D scatterplots, and change the chart type.

5. **Text Output Editor.** Text output that is not displayed in pivot tables can be modified with the Text Output Editor. Users can edit the output and change font characteristics (type, style, color, size).

6. **Syntax Editor.** Users can paste the dialog box choices into syntax window, where the user's selections appear in the form of command syntax. Users can then edit the command syntax to use special features that are not available through dialog boxes. In addition, users can also save commands in a file to be used at the next session.

In this research, SPSS which will be used SPSS version 20 for test validity and reliability of the questionnaire results that has been given by the respondent. This version provides faster rendering of pivot tables. Pivot tables in version 20 is much faster than previous versions, but still maintaining full support for pivoting and editing. If the user uses a fast rendering of lightweight tables in version 19, users will find comparable results for pivot tables in version 20. Users who require compatibility with previous prior to

20 can choose to generate legacy tables (referred to as full-featured tables in version 19) [13].

2.7 Previous Research

One of the step in the literature study process is studies of related research that discuss the same theme. Related research can serve as a reference for the research to be conducted. Reference related research is journalshat discussed the standardization of ISO 25010. Each advantages and disadvantages of each relevant research described in Table 2.9. Below.x

Table 2.9: Adjustment Result of ISO 25010 Quality Model in Product Quality Dimension

No	Journal	Author, Year	Advantages	Disadvantages
1	Assessing the Quality of M-Learning Systems Using ISO/ IEC 25010 [2]	Anal Acharya and Devadatta Sinha (2013).	This research is good enough and detail, because it first formulates the characteristics in accordance with the M-Learning system then make measurements. Measurement of M-Learning quality is done by using Metric that is illustrated in numeric form, so it makes easier to see the quality value of M-Learning system.	The application of the ISO 25010 model is not appropriate in the case study of M-Learning Systems because the ISO 25010 model only measures software quality and system quality, does not measure learning characteristics such as the effectiveness of the learning objects in the context of learning, personal and collaborative learning and the learning outcome.
2	SOAQM: Quality Model for SOA Applications based	Joyce M. S. Franca, and Michel S.	The purpose of this research is successfully done, to find what	Testing is done with expert respondents as

	on ISO 25010 [8].	Soares (2015).	attributes are in accordance with the SOA application based on IO 25010 quality model using expert opinion and literature review.	much as seven respondents, this is associated with the validity of the minimum number of respondents. There is a generic nature of the ISO 25010 model that does not apply to SOA domains.
3	Applying ISO/ IEC 25010 Standard to Prioritize and Solve Quality Issues of Automatic ETL Processes [21].	Sofia Ouhbi, Ali Idri, Jose Luis, Ambrosio Toval and Halima Benjelloun (2014).	The objective of this research is to identify what requirements are involved in evaluating product quality software from mPHR (Mobile Personal Health Record) system and to evaluate the extent of mPHR requirements on product quality characteristics using ISO / IEC 25010. This research is also useful because it has provided an overview and evaluation of the mPHR system to be used as a reference for stakeholders, developers and evaluators.	Some characteristics, through certain sub characteristics, are more influenced by the mPHR requirements than others, particularly, Functional suitability, Reliability, Performance efficiency, Operability and Security characteristics.
4	Measuring Public Value UX based on ISO/ IEC	Ashok Sivaji, Noorfarhana Abdollah, Soo	The purpose of this research is to measure the value of user experience	The study was limited to usability characteristics and

	25010 Quality Attributes [3].	Shi Tzuaan, Siti Hamimah Rasidi and Yoong SIew Wai (2015).	of the people towards the use of job-seeking website of E-Government Malaysia. The research method used by measuring the quality objectively with qualitative measurement.	quality in use dimensions. The sample used is limited to undergraduate graduates with a total of 23 respondents so that the results are considered not enough to represent the fresh graduate population in the measurement of Malaysian E-Government job-seeking website.
5	An Application of The ISO/IEC 25010 Standard in The QUALITY IN USE Assesment of An Online Health Awareness System [11].	Azham Hussain and Emmanuel O. C. (2015).	The quality measurement stages performed in this study are concise and clear. Measurements were carried out with usability testing, attitudinal questionnaire and observation. Overall, the satisfaction value on the E-Ebola Awareness System is good, at 67.50.	The researchers explained that the study only measures Quality in Use on the E-Ebola Awareness System, but the characteristics measured do not match the Quality in Use characteristics based on the ISO 25010 standard.

Chapter 3

RESEARCH METHODOLOGY

3.1 Problem Analysis

Software assessment is considered important for two parties, for developers and for end users. For developers making a software must be appropriate and provide quality results and have no defect for use by the public or end users. For end users using quality software and defect-free functionality will assist in performing activities.

Case study for this research is web application on Customer to Customer (C2C) E-Commerce which should provide good security, comfort, completeness and ease of functionality to every users. Security is about from all sides of the security of user data, payments that should be done by users at the time of purchase and all activities performed by the user associated with the software so as not to be attacked by irresponsible parties. Functional completeness and ease of use that should be the focus, so that the software can compete and could be considered by the public. Convenience aspect which also could be a form of quality assessment of an application.

Ensuring a truly quality software should be done with software quality assurance or well known as SQA. The use of SQA method in testing software quality could be done with the existing model. Testing the quality of web application which case study are Bukalapak (www.bukalapak.com) and Tokopedia (www.tokopedia.com) is using ISO 25010 Quality Model. ISO 25010 is an update of ISO 9126 that is addition to sub characteristics and sub characteristics separation become characteristic. The Selection of ISO 25010 Quality Model is by reason of providing more detailed assessment result with addition of sub characteristics.

3.2 Research Methodology

The application quality testing of Bukalapak and Tokopedia have several stages. The stages are illustrated in the following Figure 3.1. Below.

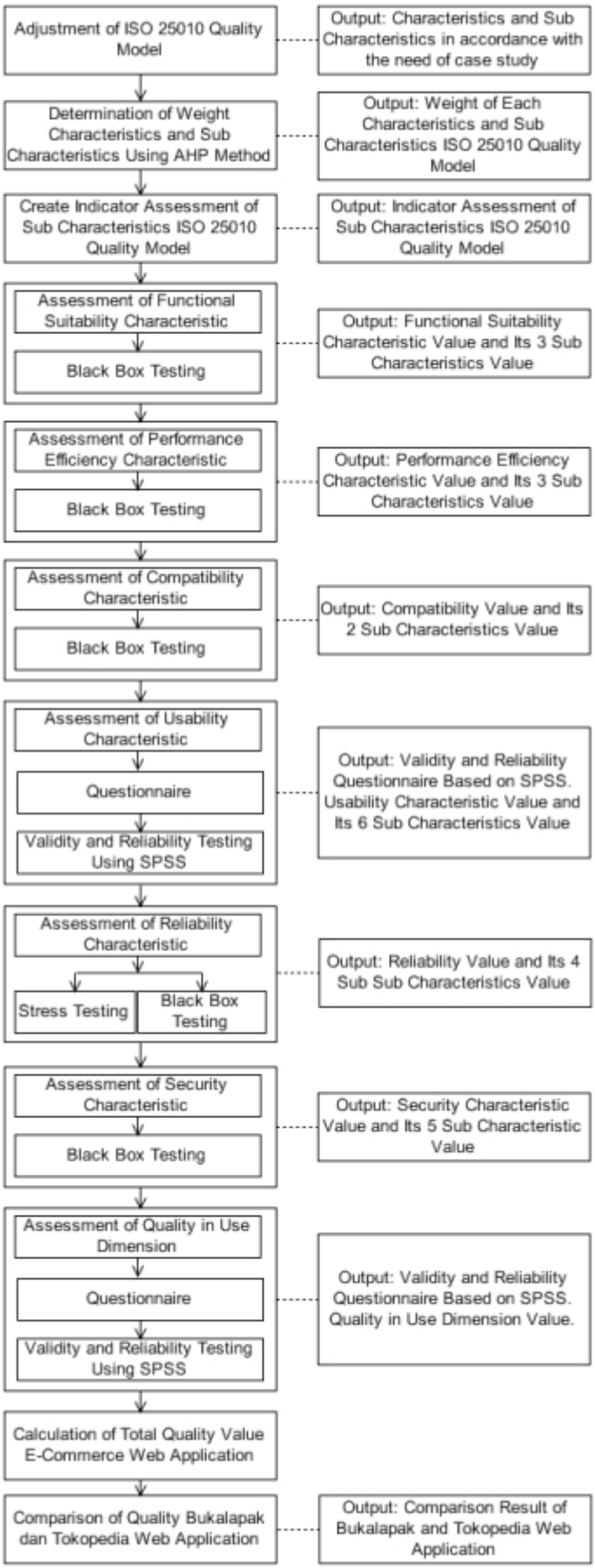


Figure 3.1: Stages of Application Quality Testing of E-Commerce Website

Figure 3.1. Above explains the first step is weighting of characteristics and sub characteristics ISO 25010 Quality Model until comparation between both software of E-Commerce website.

3.2.1 Adjustment of ISO 25010 Quality Model

Adjustment of ISO 25010 Quality Model made in accorandce with the needs of E-Commerce web application. This research was conducted by testing six characteristics and 23 sub characteristics on Product Quality dimension and eight characteristics and 31 characteristics, and five characteristics and nine sub characteristics on Quality in Use dimension. Adjustment of ISO 25010 Quality Model also based on previous research by Oscar Lind in 2012 in the research "An E-commerce Platform Evaluation based on the DoSAM Framework" that says "Described in the ISO/IEC 25010 standard, two quality factors can be identified as suitable for contributing for obtaining a higher degree of developer focus: maintainability and portability.". So the adjustment of ISO 25010 Quality Model on Maintainability and Portability characteristic is not used in this research. Table 3.1. Below is adjustment result of ISO 25010 Quality Model in Product Quality Dimension.

Table 3.1: Adjustment Result of ISO 25010 Quality Model in Product Quality Dimension

Characteristic	Definition	Sub Characteristic	Definition
Functional Suitability	Degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions.	Functional Completeness	Degree to which the set of functions covers all the specified tasks and user objectives.
		Functional Correctness	Degree to which the functions provides the correct results with the needed degree of precision.
		Functional Appropriateness	Degree to which the functions facilitate the

			accomplishment of specified tasks and objectives.
Performance Efficiency	Represents the performance relative to the amount of resources used under stated conditions.	Time Behavior	Degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.
		Resource Utilization	Degree to which the amounts and functions, meet requirements.
		Capacity	Degree to which the maximum limits of the product or system, parameter meet requirements.
Compatibility	Degree to which a product, system or component can exchange information with other products, systems or components, and/ or perform its required functions, while sharing the same hardware or software environment.	Co-Existence	Degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product.
		Interoperabillity	Degree to which

			two or more systems, products information hat has been exchanged.
Usability	Degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.	Appropriate Recognisability	Degree to which users can recognize whether a product or system is appropriate for their needs.
		Learnability	Degree to which a product or system enables the user to learn how to use it with effectiveness, efficiency emergency situations.
		Operability	Degree to which a product or system is easy to operate, control and appropriate to use.
		User Error Protection	Degree to which a product or system protects users against making errors.
		User Interface Aesthetics	Degree to which a user interface enables pleasing and satisfying interaction for the user.
		Accessibillity	Degree to which a product or system can be used by people with the capabilities to

			achieve a specified goal in a specified context of use.
Reliability	Degree to which a system, product or component performs specified functions under specified conditions for a specified period of time.	Maturity	Degree to which a system, product or component meets needs for reliability under normal operation.
		Availabillity	Degree to which a product or system is operational and accessible when required for use.
		Fault Tolerance	Degree to which a system, product or component operates as intended despite the presence of hardware or software faults.
		Recoverabillity	Degree to which, in the event of an interruption or a failure, a product directly affected and re-establish the desired state of the system.
Security	Degree to which a product or system protects information and data so that persons or other products or systems	Confidentiality	Degree to which the prototype ensures that data are accessible only to those authorized to have access.

	have the degree of data access appropriate to their types and levels of authorization.	Integrity	Degree to which a system, product computer programs or data.
		Non-Repudiation	Degree to which actions or events cannot be repudiated later.
		Accountabillity	Degree to which the actions of an entity can be traced uniquely to the entity.
		Authenticity	Degree to which the identity of a subject or resource can be proved to be the one claimed.

Table 3.2. Below is adjustment result of ISO 25010 Quality Model in Quality in Use Dimension.

Table 3.2: Adjustment Result of ISO 25010 Quality Model in Quality in Use Dimension

Characteristic	Definition	Sub Characteristic	Definition
Effectiveness	Accuracy and completeness with which users achieve specified goals (ISO 9241-11).		
Efficiency	Resources expended in relation to the accuracy and completeness with which users achieve goals (ISO 9241-11).		
Satisfaction	Degree to which user needs are satisfied when a product or system is used in a specified context of use.	Usefulness	Degree to which a user is satisfied with their perceived results of use and the consequences of use.
		Trust	Degree to which a user or other stakeholder has confidence that a product or system will behave as intended intended.
		Pleasure	Degree to which a user obtains pleasure from fulfilling their personal needs.
		Comfort	Degree to which the user is satisfied with physical comfort.
Freedom from Risk	Degree to which a product or system mitigates the potential risk to economic status, human life, health, or the environment.	Economic Risk Mitigation	Degree to which a product or system mitigates the potential risk to financial status, efficient operation, commercial property, reputation or other resources in the intended contexts of use.
		Healthy and Safety Risk Mitigation	Degree to which a product or system mitigates the potential risk to people in the intended contexts of use.
		Environmental Risk Mitigation	Degree to which a product or system mitigates the potential risk to property or the environment in the intended contexts of use.
Context Coverage	Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in both specified contexts of use and in contexts beyond those initially explicitly identified.	Context Completeness	Degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in all the specified contexts of use.
		Flexibility	Degree to which a product or system can be used with effectiveness, efficiency, satisfaction in contexts beyond those initially specified in the requirements.

3.2.2 Characteristic and Sub Characteristic Weight Determination ISO 25010 Quality Model

After adjusting ISO 25010 Quality Model, the next step is to determine the weight of characteristic and sub characteristic ISO 25010 Quality Model with Analytical Hierarchy Process (AHP) Method. In this research will be determined the weight of the two dimensions of testing, which are Product Quality and Quality in Use. Each of dimension have six characteristics and 23 sub characteristics in Product Quality dimension and five characteristics and nine sub characteristics in Quality in Use dimension. Implementation of AHP method is done with BPMSG AHP Priority Calculator tool. This tool is used as a tool to make decisions on weight calculations that produce the most priority to lowest priority. Tools made by Klaus D. Goepel which can be accessed via http://bpmsg.com/academic/ahp_calc.php.

This weight determination is done with questionnaires using 30 respondents. Respondents must have meet the requirements. The requirements are experienced on using E-Commerce application and have a background in the field of technology, both the developers and users with Bachelor degree of Computer and Bachelor degree of Informatic Engineering. With the requirements to be met by the respondents, weighting prority is expected to produce an objective and trustworthy priority sequence in each characteristic and sub characteristic.

Weight determination based on the questionnaire will be obtained the result in the form of characteristic and sub characteristic mode which then will be inputted to BPMSG tools. Table 3.3. Below is AHP intensity of pairwise comparison.

Table 3.3: Intensity of Pairwise Comparison AHP [29]

Intensity	Definition	Explanation
1	Equal Importance	Two elements contribute equally to the objective.
3	Moderate Importance	Experience and judgement slightly favor one element over another.
5	Strong Importance	Experience and judgement strongly favor one element over another.
7	Very Strong Importance	AccuracyOne element is favored very strongly over another. Its dominance is demonstrated in practice.
9	Extreme Importance	The evidence favoring one element over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values.	
Reverse	If factor i has one of the above numbers assigned to it when compared to factor j, then j has the reciprocal value when compare to i.	

The stages of weight determination of characteristics and sub characteristics with BPMSG AHP Priority Calculator tools are as follows:

1. Enter the number of characteristic or sub characteristic to be compared, as shown in Figure 3.2. Below.

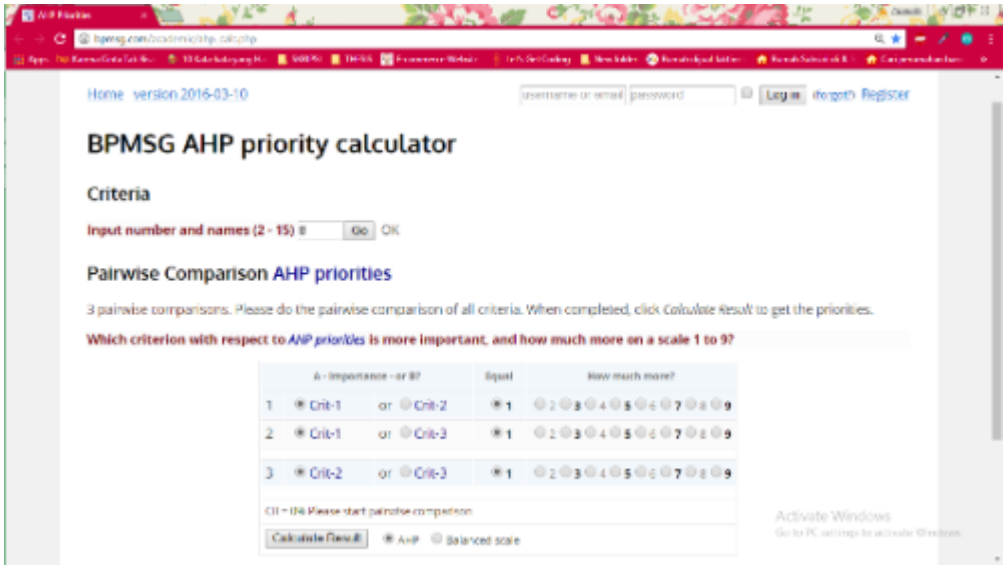


Figure 3.2: Enter Number of Characteristics atau Sub Characteristics

2. Input characteristics or sub characteristics that will be compared, as shown in Figure 3.3. Below.

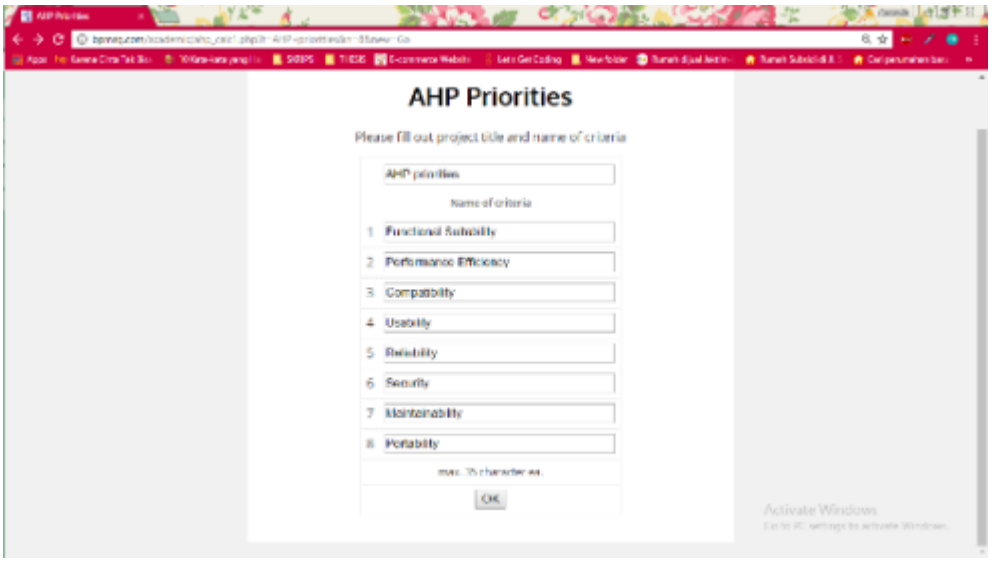


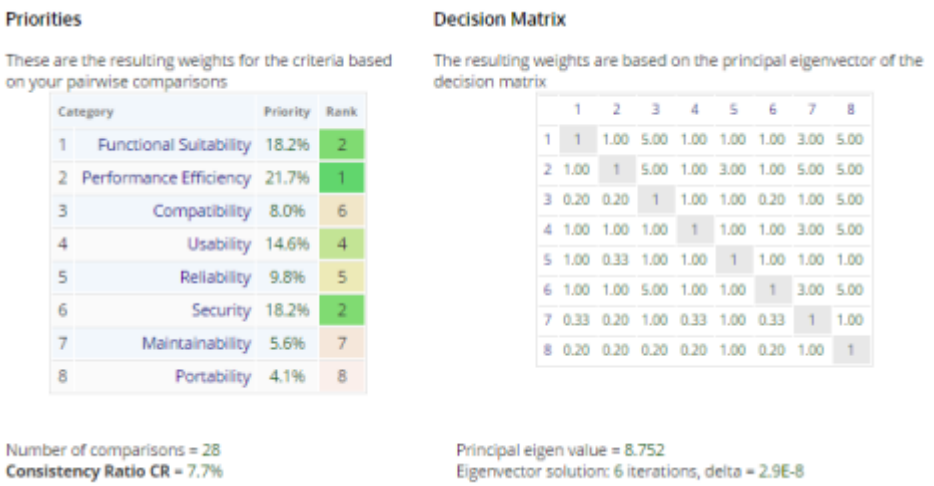
Figure 3.3: Input Characteristic or Sub Characteristic

3. Compare the characteristics or sub characteristics with each other using AHP pairwise comparison (see Table 3.1.) according to mode of

respondents. Then press Calculate Result button, as shown in Figure 3.4. Below.

Figure 3.4: Characteristic or Sub Characteristic Pairwise Comparison

4. If Concistency Ratio value $\leq$ 10%, then characteristic or subcharacteristic ranking and the decision matrix that reputed as a consistence value appear, and could be serving as a reference for the weighting determination that could be seen in Figure 3.5. Below.



Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Functional Suitability	18.2%	2
2	Performance Efficiency	21.7%	1
3	Compatibility	8.0%	6
4	Usability	14.6%	4
5	Reliability	9.8%	5
6	Security	18.2%	2
7	Maintainability	5.6%	7
8	Portability	4.1%	8

Number of comparisons = 28
Consistency Ratio CR = 7.7%

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5	6	7	8
1	1	1.00	5.00	1.00	1.00	1.00	3.00	5.00
2	1.00	1	5.00	1.00	3.00	1.00	5.00	5.00
3	0.20	0.20	1	1.00	1.00	0.20	1.00	5.00
4	1.00	1.00	1.00	1	1.00	1.00	3.00	5.00
5	1.00	0.33	1.00	1.00	1	1.00	1.00	1.00
6	1.00	1.00	5.00	1.00	1.00	1	3.00	5.00
7	0.33	0.20	1.00	0.33	1.00	0.33	1	1.00
8	0.20	0.20	0.20	0.20	1.00	0.20	1.00	1

Principal eigen value = 8.752
Eigenvector solution: 6 iterations, delta = 2.9E-8

Figure 3.5: Characteristic or Sub Characteristic Ranking and Matrix

5. If Concistency Ratio value > 10%, then characteristic or sub characteristic comparison should be repeated to third phase. Moreover, this tool also provide recommendation to change the comparison that have been done by users so that the value of Concistency Ratio (CR) can be qualified, as shown in Figure 3.6. Below.

Figure 3.6: Pairwise Comparison Does Not Meet CR Value

3.2.3 Design of Sub Characteristic Instrument ISO 25010

After adjusting of ISO 25010 Quality model, the next step is designing instrument of each sub characteristic from both dimension ISO 25010 Quality Model. Designing instrument aims to test the application based on observation of both applications and the distribution of questionnaires to users of Bukalapak and Tokopedia web application. Every test instrument will provide value for delivering the final result of a quantitative application assessment. Here are the instruments of each sub characteristic in Product Quality and Quality in Use dimension.

3.2.3.1 Instrument of Functional Suitability Sub Characteristic

Functional Suitability testing method that used in this research is black box testing which test cases are designed in accorandce with overall functionality found in standard E-Commerce web application. Black box testing (also called functional testing) is testing that ignores the internal mechanism of a system or component and focuses solely on the outputs generated in response to selected inputs and execution conditions [26].

Functionality testing is to ensure that every function on Bukalapak and Tokopedia web application have to run in accorandce with as it should. The designed test cases define scope, approachment, resources and all activities in testing, which identified test items, tested features and testing task that will performed each task.

Functional Suitability characteristic has tree sub charateristics, these are Functional Completeness, Functional Correctness and Functional Correctness. Here are the test cases of each sub characteristic.

1. Functional Completeness Sub Characteristic

   Functional Completeness is sub characteristic to ensure whether Bukalapak and Tokopedia web application have complete functions that can facilitate user goal and the needs of user in accorandce with E-Commerce website in general. Designing the instruments on sub characteristic based on observation that have been done by researcher to E-Commerce website similar to Bukalapak and Tokopedia that is Customer to Customer (C2C) with top five ranking according to Online research – Nusaresearch Omnibus (PopularBrand Index) on September 2015. This test will be performed on two E-Commerce web application they are Bukalapak and Tokopedia using Guttmann scale, where th given statement is “Yes” or “No”. Table 3.4. Below is test cases of sub characteristic Functional Completeness.

   Table 3.4: Test Case of Functional Completeness Sub Characteristic

No	Test Case	Exoected Result
1	Application has registration function as new user.	Yes
2	Application has login function connected to Facebook.	Yes
3	Application has login function connected to Yahoo.	Yes
4	Application has login function connected to Google.	Yes

5	Application has product category.	Yes
6	Application has search function.	Yes
7	Application has wishlist feature.	Yes
8	Application has rating feature.	Yes
9	Application has filter function of certain categories.	Yes
10	Application has sort function of certain categories.	Yes
11	Application has rating feature to product.	Yes
12	Application has share feature to Line application.	Yes
13	Application has share feature to Facebook application.	Yes
14	Application has share feature to Twitter application.	Yes
15	Application has share feature to Google+ application.	Yes
16	Application has share feature to Pinterest application.	Yes
17	Application has product specification (product detail information).	Yes
18	Application has seller information.	Yes
19	Application has chat feature.	Yes
20	Application has a feature of providing a review of a product already purchased.	Yes
21	Application has product discussion through Q&A.	Yes
22	Application has Shopping Cart.	Yes
23	Application has electronic payment system.	Yes
24	Application has help menu.	Yes
25	Application has feature of adding product to sale.	Yes
26	Application has feedback feature.	Yes
27	Application has function to provide notification.	Yes
28	Application has feature to check transaction status.	Yes
29	Application has bargain feature.	Yes
30	Application has refund feature.	Yes
31	Application has pre-order feature.	Yes
32	Application has feature to favorite product.	Yes
33	Application has forgot password feature.	Yes
34	Application provide statistics of seller information.	Yes
35	Application has subscription feature.	Yes
36	Application has seller profile setting feature.	Yes
37	Application has feature to upload photos connected to Instagram for seller.	Yes
38	Application has feature to upload photos connected to Facebook for seller.	Yes
39	Application has premium account for seller.	Yes
40	Application has logout menu.	Yes

2. Functional Correctness and Functional Appropriateness Sub Characteristic

   Sub characteristics measurement aims to ensure whether the function contained in the application to provide the correct results. Functional Appropriateness aims to ensure whether the function contained in Bukalapak and Tokopedia web application provide the right result in accorandce with user instructions. Here is test case of Functional Correctness and Functional Appropriateness which would be tested on Bukalapak and Tokopedia website application designed in Table 3.5. Below.

   Table 3.5: Test Case of Functional Correctness and Functional Appropriateness Sub Characteristics

No	Test Case		Exoected Result
1	Registration		
	a	Input registration data correctly in accordance with registration terms.	Registration success and show application home page or resuming user activities before.
	b	Input registration data incorrectly in accorandce with registration terms.	Show error notification that entered data does not meet the registration terms.
	c	Input registration data that have already been registered.	Show notification that the entered data have been already registered.
2	Login		
	a	Input login data correctly.	Login success and display application home page or resuming user activities before.
	b	Input login data incorrectly.	Unable to login and display an error message that data user has entered does not match with registered data.
	c	Login with correct Facebook account.	Login success and display application home page or resuming user activities before.
	d	Login with incorrect Facebook account.	Unable to login with Facebook and display an error message that data user has entered is not correct.
	e	Login with correct Google+ account.	Login success and display application home page or resuming user activities before.
	f	Login with incorrect Google+ account.	Unable to login with Google+ and display an error message that data user has entered is not correct.

	g	Login with correct Yahoo account.	Login success and display application home page or resuming user activities before.
	h	Login with incorrect Yahoo account.	Unable to login with Yahoo and display an error message that data user has entered is not correct.
3	Forgot Password		
	a	Forgot password when login.	User input registered email and reset password through email sent by application.
4	Select Product CategoryYes		
	a	Select one product category. Example: Electronic category.	Display electronic categoryYes
	b	Filter product by shipment. Example: TIKI	Product filtered by TIKI shipment only.
	c	Filter combination using available filter that are price range, shipment and location.	Product filtered by combination filter choosed.
5	Search Product		
	a	Search “iPhone SE”	Display iPhone SE products.
6	Select Product		
	a	Order product by entering stock quantity exceeds to stock provided by seller.	Order can not be processed into shopping cart and notifies user that quantity inputted exeeds the availability stock.
	b	Order product by entering stock quantity according to stock provided by seller.	Order processed into shopping cart.
	c	Sort product with lowest price.	Product sorted from lowest price.
	d	Sort product with highest price.	Product sorted from highest price.
	e	Sort product with relevance.	Product sorted based on relevance.
	f	Sort product with the newest.	Product sorted based on the newest.
	g	Press “Buy” button to buy product.	Selected product insert to shopping cart.
7	Shopping Cart		
	a	Delete order in shopping cart.	Order product will be deleted.
	b	Change quantity product from shopping cart.	Order quantity changed.
8	Rating and Comment		
	a	Rating and comment on products	Rating and comment success.

		previously purchased by users.	
	b	Rating and comment on a product that has never been purchased before by users.	No rating and comment added.
9	Payment Transaction		
	a	Using valid voucher code for payment.	Payment success and get payment notification via email or sms.
	b	Using invalid voucher code for payment.	Payment not success and show notification the inserted voucher code is invalid.
	c	Transfer payment method and enter correct payment code in accordance with notification.	Transaction will be processed and display on seller page.
	d	Transfer payment method and enter incorrect payment code in accordance with notification.	Transaction will not be processed.
	e	Transaction done.	Transaction will not be processed. Product will be processed by seller and showing the notification transaction status on buyer.
10	Wishlist		
	a	Select product to wishlist.	Product inserted to wishlist.
11	Share Product		
	a	Share product to Facebook.	Product shared to Facebook account user.
	b	Share product to Twitter.	Product shared to Twitter account user.
	c	Share product to Google+.	Product shared to Google+ account user.
	d	Share product to Pinterest.	Product shared to Pinterest account user.
12	Subscribe		
	a	Subscribe seller.	Users always get the latest item updates from the seller account through the application home page.
13	Help		
	a	Select contact us.	Connected to customer service through online chat.
14	Chat		
	a	Chat between seller and buyer.	Seller and buyer exchanging messages

			via chat.
15	Order Tracking		
	a	Seller enters the sales receipt number.	Sales receipt number inserted will be updated on buyer's account.
16	Application Download		
	a	Download application for smartphone.	Provide link to download application through SMS.
17	Seller		
	a	Upload photo to sale by seller.	Photo uploaded.
	b	Import photo from Instagram.	Connected to Instagram and photo uploaded.
	c	Import photo from Facebook.	Connected to Facebook and photo uploaded.
	d	Seller account setting profile.	Account updated.
	e	Top up electronic balance.	Top up will be filled after payment.
	f	Cashed seller electronic balance.	Electronic balance of seller is cashed through the selected bank.
	g	Download electronic balance mutation.	Download successful.
18	Logout		
	a	Logout user account.	Account logged out and display home page application.

3.2.3.2 Instrument of Performance Efficiency Sub Characteristic

Testing sub characteristic in characteristic Performance Efficiency is performed on three sub characteristics that is Time Behavior, Resource Utilization and Capacity.

1. Time Behavior Sub Characteristic

   Testing on Time Behavior sub characteristics aims to see the capabilities of both application Bukalapak and Tokopedia in processing time and responding when applications are used. Measurement of Time Behavior is done by calculating the average response time when application running a function. This testing conducted to evaluate the compliance of a system or component with specified performance requirements [26]. Test case is done using test cases on Functional Correctness and Functional Appropriateness sub characteristic.

2. Resource Utilization Sub Characteristic

   Testing Resource Utilization sub characteristic is done by observe the processing of resources when application is running. The resource is the use of memory when the application is accessed by user and surfing the website.

3. Capacity Sub Characteristic

   Testing Capacity sub characteristic aims to see the capabilities of both application Bukalapak and Tokopedia in providing the maximum limit on the use of the application. Table 3.5. below is the test case of testing Capacity sub characteristic .

Table 3.6: Test Case of Capacity Sub Characteristic

No	Test Case	Expected Result
1	Input product into wishlist more than 100 products.	More than 100 selected products are on wishlist.
2	Input more than 100 products into shopping cart.	More than 100 selected products are on shopping cart.
3	Add more than 100 favorite stores to favorite stores menu.	More than 100 favorite stores are on favorite stores menu.

3.2.3.3 Instrument of Compatibility Sub Characteristic

Testing Compatibility sub characteristic is done in two its sub characteristic, that are Co-Existence and Interoperability sub characteristic.

1. Co-Existence Sub Characteristic

   Testing Co-Existence sub characteristic aims to determine the capabilities of Bukalapak and Tokopedia web application running on certain web browser application. Testing is done by opening both application sites in various browser options using desktop devices, netbook and notebook (fixed site www.bukalapak.com not redirected to m.bukalapak.com). Table 3.7. Below is test case of Co-Existence sub characteristic.

Table 3.7: Test Case of Co-Existence Sub Characteristic

No	Test Case	Expected Result
1	Bukalapak and Tokopedia sites are accessed using Google Chrome browser.	Bukalapak and Tokopedia sites running well (no features could not run).
2	Bukalapak and Tokopedia sites are accessed using Internet Explorer browser.	Bukalapak and Tokopedia sites running well (no features could not run).
3	Bukalapak and Tokopedia sites are accessed using Safari browser.	Bukalapak and Tokopedia sites running well (no features could not run).
4	Bukalapak and Tokopedia sites are accessed using Mozilla Firefox browser.	Bukalapak and Tokopedia sites running well (no features could not run).
5	Bukalapak and Tokopedia sites are accessed using Opera browser.	Bukalapak and Tokopedia sites running well (no features could not run).

2. Interoperability Sub Characteristic

Testing Interoperability sub characteristic aims to determine the capabilities of both application Bukalapak and Tokopedia in exchanging the information through other system. Table 3.8. Below is test case of Interoperability sub characteristic.

Table 3.8: Test Case of Interoperability Sub Characteristic

No	Test Case	Expected Result
1	Sign up with Google account.	Data has registered is according to the connected Google account.
2	Sign up with Facebook account.	Data has registered is according to to the connected Facebook account.
3	Sign up with Yahoo account.	Data has registered is according to to the connected Yahoo account.
4	Login with Google account.	Login data is according to the connected Google account.
5	Login with Facebook account.	Login data is according to the connected Facebook account.
6	Login with Yahoo account.	Login data is according to the connected Yahoo account.
7	Login with Email account.	Login data is according to the connected Email account.
8	Payment with virtual account number.	Payment transaction automatically confirmed.
9	Share product to Facebook.	Product shared to Facebook user's home page.
10	Share product to Twitter.	Product shared to Twitter user's home page.
11	Share product to Google+.	Product shared to Google+ user's home page.
12	Share product to Pinterest.	Product shared to Pinterest user's home page.
13	Share product to Instagram.	Product shared to Instagram user's home page.
14	Share product to Blogger.	Product shared to Blogger user's home page.
15	Order Tracking.	Application provide delivery status information of products purchased by the user.

3.2.3.4 Instrument of Usability Sub Characteristic

Testing Usability characteristic is done by questionnaire that use the application of Bukalapak and Tokopedia. Statement in the questionnaire of this research required a sample as respondents. Determination the number of samples is using Slovin formula with the following equation.

$$n = \frac{N}{(Nx\alpha^2)+1}$$

$Where:$

$n : Sample\ Size$

$N : Population\ Size$

$\alpha : AMargin\ \ of\ \ Error(\alpha = 0.05)$

According to StatShow data, is a site of website analysis that provide website data and information, number of user and Population Size (N) from Bukalapak is about 51,003,900 and Tokopedia is about 64,761,600. So Total Population Size (N) from both websites is about 115,765,500. Since the questionnaire will be given to users from both Bukalapak and Tokopedia websites, the Population Size (N) used for calculations on the Slovin formula is the average of the total population of Size (N) as follows.

$$N = \frac{BukalapakUsers+TokopediaUsers}{2}$$

$$N = \frac{51.003.900+64.761.600}{2}$$

$$N = \frac{115.765.500}{2}$$

$$N = 57.882.750$$

Based on the calculation above, the total Population Size (N) that used in this research is 57.882.750 and with a Margin of Error $(\alpha = 0.05)$. Then to have the number of sample size (N) is calculated on the following formula below.

$$n = \frac{N}{(Nx\alpha^2)+1}$$

$$n = \frac{57.882.750}{(57.882.750x(0.05)^2)+1}$$

$$n = \frac{57.882.750}{144.707,75}$$

$$n = 399,99$$

$$n \approx 400$$

Based on calculations with Slovin formula above, the number of respondents obtained as much as 400 respondents with a level of confidence is 95%.

Before spreading the questionnaire to 400 respondents, the questionnaire first tested the validity and reliability to 30 respondents. Validity indicates the degree of determination of the data actually happened on the object with the data that can be collected by researchers [23]. The results of the research valid if there is a similarity between the data collected by the data that is actually happening on the object under research. The instruments are valid means of measuring instruments used to obtain data (measure) were valid. Valid means the instrument can be used to measure what should be measured [23]. According Masrum, in Sugiyono 2008 [23], states that the item has a positive correlation with the criterion (total score) as well as a high correlation also indicates that the item has a higher validity. The validity result can be seen by using the Pearson Correlation value between each variable item with the variable it self. The minimum number of Pearson correlation value to be valid for the research is 0,3610 [23]. It refers to Table R by using the value of signicance level at 5% with 30 number of sample [23]. Reliability is related to the degree of consistency or constancy of data in a certain time interval [23]. The instrument has a reliability can be used to measure many times that produce the same data (consistent). According Sugiyono in 2008[23], that reliability is the extent to which the results of measurements using the same object, will generate the same data. Cronbach alpha value on reliability is compared with consistency value that explains in following Table 3.9. Below.

Table 3.9: Reliability Index Criteria [Sugiyono (2008)]

Level	Interval	Criteria
1	< 0.200	Very Low
2	0.200 – 0.399	Low
3	0.400 – 0.599	Moderate
4	0.600 – 0.799	High
5	0.800 – 1.000	Very High

Statement in the questionnaire is adopted from USE Questionnaire by Arnold M. Lund (2001) then adjusted with the needs of this research. The

statements represent every sub characteristics from characteristic of Appropriateness Recognisability, Learnability, Operability, User Error Protection, User Interface Aesthetics and Accessibility. Table 3.10. Below is the Instrument of Usability characteristic.

Table 3.10: Instrument of Usability Characteristic

No	Sub Characteristic	Variable	Statement
1	Appropriate Recognisability	AR	I feel this application fits to my needs.
2	Learnability	LN1	I feel this application is easy to learn.
		LN2	I learned how to use this application quickly.
3	Operability	OP1	I feel this application is easy to use.
		OP2	I feel this application require a short step when used.
4	User Error Protection	UE1	I can prevent from mistakes quickly and easily.
		UE2	I can recover from mistakes quickly and easily.
5	User Interface Aesthetics	UI1	I feel application's view is user friendly.
		UI2	I feel application's view is consistent.
6	Accessibility	AC1	I feel the application can be used under certain conditions.
		AC2	I feel the application can be used with a wide coverage.

Testing using Likert scale as scale measurement in testing instrument, where each item in usability instrument have gradation from very positive to very negative. [24]. Table 3.11. Below is Likert scale interpretation.

Table 3.11: Likert Scale Interpretation

Scale	Interpretation	
1	STS	Strongly Disagree
2	TS	Disagree
3	N	Impartial
4	S	Agree
5	SS	Strongly Agree

The calculated result scale is then calculated by the following formula.
$Q = \frac{\sum IxS}{MaxU} x100\%$

$\sum IxS = (IxS)_1 + (IxS)_2 + ... + (IxS)_n$
$Where:$
$Q : Questionnaire\ Value$
$I : Interpretation\ respondents\ \ answer(STS,TS,N,S,SS)$
$S : Likert\ Scale$
$MaxU : Maximum\ Value\ (Total\ Statements\ x\ The\ Highest\ Likert\ Scale)$

3.2.3.5 Instrument of Reliability Sub Characteristic

Designing instrument of Reliability sub characteristicis based on observation of each function related to application reliability when used in certain conditions. Testing Reliability Characteristicis done in its four sub characteristic that are Maturity, Availability, Fault Tolerance and Recoverability. Here is the instrument of each sub characteristic in Reliability characteristic.

1. Maturity Sub Characteristic

   Testing Maturity sub characteristic aims to ensure application Bukalapak and Tokopedia web application can survive from software failures or errors. The designed of instrument Maturity sub characteristic based on observation that have been done by researcher on both applications by observing the functions related to reliability of application. According to booklet by Duy Huynh [12] maturity testing is done by; (1) The objective of testing is to show that the system and software work, (2) The objective of testing is based on system requirements. The results of further observations are used to make the test cases described in Table 3.12. Below.

Table 3.12: Test Case of Maturity Sub Characteristic

No	Test Case	Expected Result
1	Login with account that does not match with account that has been registered.	Unable to login.
2	Added 100 products for sale.	Products successfully added.
3	Push promoted for 100 products sales.	Push promoted success.
4	Added 100 products to shopping cart.	Products successfully added to shopping cart.

2. Availability Sub Characteristic

   Testing of Availability sub characteristics aims to see application performance to fulfill needs of user when application used. Table 3.13. Below is test case of Availability sub characteristic.

Table 3.13: Test Case of Availability Sub Characteristic

No	Test Case	Expected Result
1	Access application in Days of National Online Shopping	Application running normally.
2	Access application in Ramadhan Sale	Application running normally.

3. Fault Tolerance Sub Characteristic

Testing of Fault Tolerance sub characteristic aims to ensure application Bukalapak and Tokopedia are able to maintain application performance when happens a system error or human error. Table 3.14. Below is test case of Fault Tolerance sub characteristic.

Table 3.14: Test Case of Fault Tolerance Sub Characteristic

No	Test Case	Expected Result
1	Create an account with inappropriate email address 10 times.	Account was not successfully created.
2	Sign up account with incorrect password terms 10 times.	Account was not successfully created.
3	Login with incorrect registered account 10 times.	Unable to login. User is requested to double check the username and password entered whether it is in accordance with the previously registered account.
4	Payment using incorrect virtual account code three times.	Unable to continue the next process.

4. Recoverability Sub Characteristic

   Testing Recoverability sub characteristic aims to ensure application Bukalapak and Tokopedia are able to resuming their tasks and recovering user in case of software error or trouble in network connection. Table 3.15. Below is test case of Recoverability sub characteristic.

Table 3.15: Test Case of Recoverability Sub Characteristic

No	Test Case	Expected Result
1	Disconnect internet connection when ordering products.	Ordering process can not be done and the application notifies that the internet connection is lost.
2	Enable airplane mode when ordering products.	Ordering process can not be done and the application notifies that the internet connection is lost.
3	Device shut down when ordering product.	Order process can be resumed when the device is turn on.

3.2.3.6 Instrument of Security Sub Characteristic

Instrument of Serurity sub characteristic using Goal-Question-Metrics (GQM) to define security of a software which developed by Shareeful Islam and Paolo Falcarin [Islam, S. and Falcarin, P. (2012). Measuring security requirements for software security. Cybernetic Intelligent Systems (CIS), IEEE 10th International Conference, pages 70– 75]. Adopted instrument from GQM is test plan for each sub characteristic in application testing.

1. Confidentiality Sub Characteristic

   Testing Confidentiality sub characteristic aims to see application of Bukalapak and Tokopedia are able to provide protection of access rights on each user. Design of instrument Confidentiality sub characteristic based on adopted from GQM on permission of access rights and observation of the functions of Bukalapak and Tokopedia web application that have been done by researcher related to security of user access rights. Table 3.16. Below is test case of Confidentiality sub characteristic.

Table 3.16: Test Case of Confidentiality Sub Characteristic

No	Test Case	Expected Result
1	Fill registration data with emptying one field.	Display an error message to fill empty field.
2	Fill registration data with less than 4 characters.	Display an error message password is too short.
3	Fill confirmation password different from the password data to be used.	Display an error message password does not match the confirmation password field.
4	Fill registration data with incomplete email address.	Display an error message email does not match.
5	Fill registration data using the same email address.	Display an error message email already exists.

2. Integrity Sub Characteristic

   Testing Integrity sub characteristic aims to ensure application of Bukalapak and Tokopedia are able to prevent unauthorized access rights into the system. Design of instrument Integrity sub characteristic based on adopted from GQM on Integrity and observation of the functions of Bukalapak and Tokopedia web application that have been done by researcher related to the prevention of user access rights on user permission. Table 3.17. Below is test case of Integrity sub characteristic.

Table 3.17: Test Case of Integrity Sub Characteristic

No	Test Case	Expected Result
1	Fill login data: a. Incorrect username. b. Correct password.	Displays an error message to check the username and password entered.
2	Fill login data: a. Correct username. b. Inorrect password.	Displays an error message to check the username and password entered.
3	Reset Password	Sends a password reset message to email.
4	Login using Facebook account.	Displays a verification message to sign in with a connected Facebook account.
5	Login using Google+ account.	Displays a verification message to sign in with a connected Google+ account.
6	Login using Yahoo account.	Displays a verification message to sign in with a connected Yahoo account.

3. Non-Repudiation Sub Characteristic

   Testing Non-Repudiation sub characteristic aims to ensure application of Bukalapak and Tokopedia are able to provide evidence of user action or user transaction. Design instrument of Non-Repudiation sub characteristic based on adopted from GQM and observation of the functions of Bukalapak and Tokopedia web application that have been done by researcher related to the evidence of user action and user transaction. Table 3.18. Below is test case of Non-Repudiation sub characteristic.

Table 3.18: Test Case of Non-Repudiation Sub Characteristic

No	Test Case	Expected Result
1	Register through application site.	Application provides proof of registration by email.
2	Order product	Application provides proof of order by email or SMS.
3	Payment confirmation	Application provides proof of payment confirmation by email or SMS.
4	Cancellation order.	Application provides proof of cancellation order by email or SMS.
5	Product received.	Application provides proof of product received by email or SMS.

4. Accountability Sub Characteristic

   Testing of Accountability sub characteristic aims to ensure application of Bukalapak and Tokopedia are able to track all activities of user. Design instrument of Accountability sub characteristic based on adopted

from GQM and observation of the functions of Bukalapak and Tokopedia web application that have been done by researcher related to user activities. Table 3.19. Below is test case of Non-Repudiation sub characteristic.

Table 3.19: Test Case of Accountability Sub Characteristic

No	Test Case	Expected Result
1	View order transaction.	List of products and order transaction can be seen by user.
2	View purchase transaction.	List of products and purchase transaction can be seen by user.
3	View payment transaction.	List of current payment transaction and history of the payment can be seen by buyer.
4	View transaction of received product.	List of received product transaction and history of the receipt product before can be seen by buyer.
5	View wishlist history.	List of wishlist product can bee seen on Wishlist Menu.
6	Search history.	List of search product history can be seen on search menu.
7	Product discussion history.	Discussion product by user can be seen on discussion product view.
8	Chat history.	Chat between seller and buyer can be seen on Chat Menu.

5. Authenticity Sub Characteristic

   Testing Authenticity sub characteristic aims to ensure application of Bukalapak and Tokopedia are able to provide authenticity confirmation of user data. Design instrument of Authenticity sub characteristic based on adopted from GQM and observation of the functions of Bukalapak and Tokopedia web application that have been done by researcher related to the data entered by user. Table 3.20. Below is test case of Authenticity sub characteristic.

Table 3.20: Test Case of Authenticity Sub Characteristic

No	Test Case	Expected Result
1	Registration.	Application sends data verification through email.
2	Change password.	Change password success.
3	Update account.	Account updated.
4	Login in several browsers using different devices without logout first.	Application provides information through email that account that entered is logged in on another device.

3.2.3.7 Instrument of Quality in Use Dimension

Design instrument of Quality in Use Dimension using questionnaire which filled by respondents as users of both web application of Bukalapak and Tokopedia. Number of respondents who filled the questionnaire

of Quality in Use dimension is equal to the number of respondents who filled questionnaire in Usability characteristic. This is because the questionnaire is a unified questionnaire consisting of Usability characteristic and Quality in Use dimension. The statements are adopted from USE Questionnaire by Arnold M. Lund (2001) which then adapted to the needs of this research. The statements represent every sub characteristic of the Quality in Use dimension, which is Effectiveness, Efficiency, Satisfaction, Freedom from Risk and Context Coverage. Table 3.21. Below is instrument of Quality in Use dimension.

Table 3.21: Instrument of Quality in Use Dimension

No	Sub Characteristic	Variable	Statement
Functional Suitability	Degree to which a product or system provides functions that meet stated	Functional Completeness	Degree to which the set of functions covers all the specified tasks and user objectives.
Performance Efficiency	Represents the performanc relative to the amount of resources used under stated conditions.	Time Behavior	Degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.
		Resource Utilization	Degree to which the amounts and functions, meet requirements.
		Capacity	Degree to which the maximum limits of the product or system, parameter meet requirements.
Compatibility	Degree to which a product, system or component can exchange information with other products, systems or components,	Co-Existence	Degree to which a product can perform its required functions efficiently while sharing a common environment and

	and/ or perform its required functions, while sharing the same hardware or software environment.		resources with other products, without detrimental impact on any other product.
		Interoperabillity	Degree to which two or more systems, products information that has been exchanged.
Usability	Degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.	Appropriate Recognisability	Degree to which users can recognize whether a product or system is appropriate for their needs.
		Learnability	Degree to which a product or system enables the user to learn how to use it with effectiveness, efficiency emergency situations.
		Operability	Degree to which a product or system is easy to operate, control and appropriate to use.
		User Error Protection	Degree to which a product or system protects users against making errors.
		User Interface Aesthetics	Degree to which a user interface enables pleasing and satisfying

			interaction for the user.
		Accessibillity	Degree to which a product or system can be used by people with the capabilities to achieve a specified goal in a specified context of use.
Reliability	Degree to whicH a system, product or component performs specified functions under specified conditions for a specified period of time.	Maturity	Degree to which a system, product or component meets needs for reliability under normal operation.
		Availabillity	Degree to which a product or system is operational and accessible when required for use.
		Fault Tolerance	Degree to which a system, product or component operates as intended despite the presence of hardware or software faults.
		Recoverabillity	Degree to which, in the event of an interruption or a failure, a product directly affected and re-establish the desired state of the system.
	Degree to which a product	Confidentiality	Degree to which

Security	or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization.		the prototype ensures that data are accessible only to those authorized to have access.
		Integrity	Degree to which a system, product computer programs or data.
		Non-Repudiation	Degree to which actions or events cannot be repudiated later.
		Accountabillity	Degree to which the actions of an entity can be traced uniquely to the entity.
		Authenticity	Degree to which the identity of a subject or resource can be proved to be the one claimed.

3.2.4 Design Indicator of Sub Characteristic in ISO 25010 Quality Model

After desigining the instrument of all sub characteristics in ISO 25010 Quality model, then the next stage is analyzing the result of the designed instrument. It will be measured and compared with each indicator of sub characteristic. Here is the indicator of sub characteristic in ISO 25010 Quality Model.

3.2.4.1 Indicator of Sub Characteristic in Functional Suitability Characteristic

Analysis of all sub characteristics in Functional Suitability Characteristics is using test scenario with Guttman scale. Guttman scale is developed scale by Louis Guttman where every instrument answer must be firmed and

consistent, eg “Yes” or “No” [22]. After testing all answers “Yes” calculated the feasibility percentage. Formula of feasibility percentage can be seen in formula below.

$$Feasibility\ Percentage\ (\%) = \frac{Observed\ Score}{Score\ Maximum}$$

Then each result will be compared with assessment table from each sub characteristics as follows.

1. Indicator of Functional Completeness Sub Characteristic

   Indicator assessment of Functional Completeness sub characteristic obtained from observation of some E-Commerce web application based on similar websites then compiled by researcher. Table 3.22. Below is indicator of Functional Completeness sub characteristic.

Table 3.22: Indicator of Functional Completeness Sub Characteristic

Level	Indicator	Description
1	0% - 20%	Very Bad
2	21% - 40%	Bad
3	41% - 60%	Moderate
4	61% - 80%	Good
5	81% - 100%	Very Good

2. Indicator of Functional Correctness and Functional Appropriateness Sub Characteristic

   Indicator assessment of Functional Correctness and Functional Appropriateness sub characteristic are adopted by research of Rodriguez, M. & Piattini, M. entitled “Evaluation of Software Product Functional Suitability: A Case Study”. E-Commerce web application which has good quality if in level 4 and level 5. Level 4 and level 5 meet the three sub characteristics of Functional Suitability, that are Functional Completeness, Functional Correctness and Functional Appropriateness [19]. Table 3.23. Below is indicator of Functional Correctness and Functional Appropriateness sub characteristic.

Table 3.23: Indicator of Functional Correctness and Functional Appropriateness Sub Characteristic

Level	Indicator	Description
1	0% - 20%	There cannot be sub characteristics. It means very bad quality.
2	21% - 40%	The maximum number of sub characteristics is one. It means bad quality.
3	41% - 60%	The maximum number of sub characteristics is two. It means good enough quality.
4	61% - 80%	There are all of sub characteristics. It means good quality.
5	81% - 100%	There are all of sub characteristics. It means very good quality.

3.2.4.2 Indicator of Sub Characteristic in Performance Efficiency Characteristic

Indicator assessment of sub characteristic in Performance Efficiency characteristic will be given to each sub characteristic that are Time Behavior, Resource Utilization and Capacity. Here is indicator of each sub characteristic in Performance characteristic.

1. Indicator of Time Behavior Sub Characteristic

   Quality testing in Time Behavior sub characteristic is done by calculating the average response time of the application in running a function. The results are then compared with user satisfaction table presented by Hoxmeier and DiCesare [10]. Users get the highest satisfaction when the response time is delayed 0 seconds while the satisfaction remains within the range of 3 to 9 seconds and decreases when more than 12 seconds[10].

   Table 3.24. Below is standard measurement of user satisfaction.

   Table 3.24: Indicator of Time Behavior Sub Characteristic

Level	Indicator	Description
1	> 15	Extremely Dissatisfied
2	12 - 15	Not Satisfied
3	9 - 12	Quite Satisfied
4	3 - 9	Satisfied
5	< 3	Very Satisfied

2. Indicator of Resource Utilization Sub Characteristic

   Testing Resource Utilization sub characteristic is done by observation of memory usage when web application is running with and without

cache. The result then will be compared with indicator table of memory usage. Indicator that used in Resource Utilization sub characteristic is based on observation by researcher of five C2C websites. Table 3.25. Below is memory usage of E-Commerce web application which accessed through Google Chrome browser.

Table 3.25: Memory Usage of E-Commerce Web Application on Google Chrome

E-Commerce Website	With Cache (MB)	Without Cache (MB)
Bukalapak	112,774	81,780
Tokopedia	86,844	51,036
Elevenia	135,936	91,180
OLX	200,764	180,140
Blanja	115,352	66,288

Average of memory usage in Table 3.25. Above is the reference as an indicator of Resource Utilization which will be very good predicate and multiple of two of the average will be very bad predicate.

Table 3.26. Below is indicator of Resource Utilization sub characteristic.

Table 3.26: Indicator of Resource Utilization Sub Characteristic

Level	Memory Usage		Predicate
	With Cache (MB)	Without Cache (MB)	
1	162 – 169	126 – 133	Very Bad
2	154 – 161	118 – 125	Bad
3	146 – 153	110 – 117	Moderate
4	138 – 145	102 – 109	Good
5	130 – 137	94 – 101	Very Good

3. Indicator of Capacity Sub Characteristic

   Design indicator of Capacity sub characteristic using tesc case with Guttman scale [22]. Number of “Yes” answer will be counted and will be matched with indicator of Capacity to see application quality based on its capacity.

   Table 3.27. Below is indicator of Capacity sub characteristic.

Table 3.27: Indicator of Capacity Sub Characteristic

Level	Indicator	Description
1	No test case matches the expected result.	Capacity is very low.
2	There are 1 test case match the expected result.	Capacity is low.
3	There are 2 test cases match the expected result.	Capacity is enough.
4	There are 3 test cases match the expected result.	Capacity is high.
5	All test cases match the expected result.	Capacity is very high.

3.2.4.3 Indicator of Sub Characteristic in Compatibility Characteristic

Assessment indicator of Compatibility characteristic will be given by each sub characteristic that are Co-Existense and Interoperability. Here is indicator of each sub characteristic in Compatibility characteristic.

1. Indicator of Co-Existence Sub Characteristic

   Design indicator of Co-Existence sub characteristic refers to Guttman scale test case [22]. Number of "Yes" answer will be calculated and matched to indicator of Co-Existence sub characteristic to see the quality of web application when running in different browsers. Table 3.28. Below is indicator of Co-Existence sub characteristic.

Table 3.28: Indicator of Co-Existence Sub Characteristic

Level	Indicator	Description
1	No test case matches the expected result.	Very bad
2	There are 5-6 test case match the expected result.	Bad
3	There are 3-4 test cases match the expected result.	Moderate
4	There are 1-2 test cases match the expected result.	Good
5	All test cases match the expected result.	Very good

2. Indicator of Interoperability Sub Characteristic

   Design indicator of Interoperability sub characteristic is using Guttman scale test case [22]. Number of "Yes" answer will be calculated and matched to indicator of Interoperability sub characteristic to see the quality of web application when exchanging information with other system. Table 3.29. below is indicator of Interoperability sub characteristic.

Table 3.29: Indicator of Interoperability Sub Characteristic

Level	Indicator	Description
1	No test case matches the expected result.	Very bad
2	There are 5-6 test case match the expected result.	Bad
3	There are 3-4 test cases match the expected result.	Moderate
4	There are 1-2 test cases match the expected result.	Good
5	All test cases match the expected result.	Very good

3.2.4.4 Indicator of Sub Characteristic in Usability Characteristic

Design indicator of sub characteristic in Usability characteristic refers to he result from questionnaire given to the users of both application. Result of the calculation will be compared with score interpretation table adopted from Guritno, Sudaryono and Raharja [22] research. Table 3.30. Below is score interpretation used in this research.

Table 3.30: Indicator of Usability Sub Characteristic

Scale	Percentage of Achievement	Interpretation
1	0% - 20%	Feasibility is Very bad
2	21% - 40%	Feasibility is Bad
3	41% - 60%	Feasibility is Moderate
4	61% - 80%	Feasibility is Good
5	81% - 100%	Feasibility is Very good

3.2.4.5 Indicator of Sub Characteristic in Reliability Characteristic

Design indicator of sub characteristic in Reliability characteristic is done with its four sub characteristics, that are Maturity, Availability, Fault Tolerance and Recoverability. Here is the indicator of each sub characteristic.

1. Indicator of Maturity Sub Characteristic

   Design indicator of Maturity sub characteristic is using test case in Guttman scale [22]. Then all of “Yes” answer will be calculated and matched with indicator of Maturity sub characteristic to know the quality of application in failure defend or software failure. Table 3.31. Below is indicator of Maturity sub characteristic.

Table 3.31: Indicator of Maturity Sub Characteristic

Level	Indicator	Description
1	No test case matches the expected result.	Very bad
2	There are 1 test case match the expected result.	Bad
3	There are 2 test cases match the expected result.	Moderate
4	There are 3 test cases match the expected result.	Good
5	All test cases match the expected result.	Very good

2. Indicator of Availability Sub Characteristic

   Design indicator of Availability sub characteristic is using test case in Guttman scale [22]. Then all of "Yes" answer will be calculated and matched with indicator of Maturity sub characteristic to know the quality of application in performance to fulfill needs of user when application used. Table 3.32. Below is indicator of Availability sub characteristic.

Table 3.32: Indicator of Availability Sub Characteristic

Level	Indicator	Description
1	No test case matches the expected result.	Very bad
2	There are 1 test case match the expected result.	Bad
3	There are 2 test cases match the expected result.	Moderate
4	There are 3 test cases match the expected result.	Good
5	All test cases match the expected result.	Very good

3. Indicator of Fault Tolerance Sub Characteristic

   Design indicator of Fault Tolerance sub characteristic is using test case in Guttman scale [22]. Then all of "Yes" answer will be calculated and matched with indicator of Fault Tolerance sub characteristic to know the quality of application which a system, product or component operates as intended despite the presence of hardware or software faults. Table 3.33. Below is indicator of Fault Tolerance sub characteristic.

Table 3.33: Indicator of Fault Tolerance Sub Characteristic

Level	Indicator	Description
1	No test case matches the expected result.	Very bad
2	There are 1 test case match the expected result.	Bad
3	There are 2 test cases match the expected result.	Moderate
4	There are 3 test cases match the expected result.	Good
5	All test cases match the expected result.	Very good

4. Indicator of Recoverability Sub Characteristic

   Design indicator of Recoverability sub characteristic is using test case in Guttman scale[22]. Then all of "Yes" answer will be calculated and matched with indicator of Recoverabililty sub characteristic to know the quality of application which in the event of an interruption or a failure, a product directly affected and re-establish the desired state of the system. Table 3.34. Below is indicator of Recoverability sub characteristic.

Table 3.34: Indicator of Recoverability Sub Characteristic

Level	Indicator	Description
1	No test case matches the expected result.	Very bad
2	There are 1 test case match the expected result.	Bad
3	There are 2 test cases match the expected result.	Moderate
4	There are 3 test cases match the expected result.	Good
5	All test cases match the expected result.	Very good

3.2.4.6 Indicator of Sub Characteristic in Security Characteristic

Before designing the indicator of Security sub characteristic, then do the analysis refers to the calculation of Goal-Question-Metrics (GQM) to define the measurement of software security by [15]. Quality characteristic measurement of GQM Security is by giving score on every statement contained in instrument of every sub characteristic. Scores from metrics for every question are [15]:

$1 = Full\ Compliance$

$0.5 = Average\ Compliance$

$0 = Weak\ Compliance$

After all statements in test scenario for each sub characteristic is given a score, then total score per characteristic will be calculated by the following formula.

$$SS = \frac{\sum ScoreQn}{TotQn} x100\%$$

$$\sum ScoreQn = ScoreQ_1 + ScoreQ_2 + ... + ScoreQ_n$$

$Where:$

$SS = Score\ of\ each\ sub\ characteristic\ in\ Security\ characteristic$

$ScoreQn = Score\ given\ by\ each\ statement\ in\ test\ case$

$TotQn = Total\ test\ case\ statements$

After having score of each sub characteristic, then the result will be matched with its indicator table.

Table 3.35. Below is indicator of Confidentiality sub characteristic.

Table 3.35: Indicator of Confidentiality Sub Characteristic

Level	Indicator	Description
1	0% - 20%	The prototype ensures that data are accessible only to those authorized to have access is Very Low.
2	21% - 40%	The prototype ensures that data are accessible only to those authorized to have access is Low.
3	41% - 60%	The prototype ensures that data are accessible only to those authorized to have access is Moderate.
4	61% - 80%	The prototype ensures that data are accessible only to those authorized to have access is High.
5	81% - 100%	The prototype ensures that data are accessible only to those authorized to have access is Very High.

Table 3.36. Below is indicator of Integrity sub characteristic.

Table 3.36: Indicator of Integrity Sub Characteristic

Level	Indicator	Description
1	0% - 20%	Ability of application to prevent unauthorized access is Very Low.
2	21% - 40%	Ability of application to prevent unauthorized access is Low.
3	41% - 60%	Ability of application to prevent unauthorized access is Moderate.
4	61% - 80%	Ability of application to prevent unauthorized access is High.
5	81% - 100%	Ability of application to prevent unauthorized access is Very High.

Table 3.37. Below is indicator of Non-Repudiation sub characteristic.

Table 3.37: Indicator of Non-Repudiation Sub Characteristic

Level	Indicator	Description
1	0% - 20%	Ability of the application to provide evidence against the action/ transaction that has been done is Very Low.
2	21% - 40%	Ability of the application to provide evidence against the action/ transaction that has been done is Low.
3	41% - 60%	Ability of the application to provide evidence against the action/ transaction that has been done is Moderate.
4	61% - 80%	Ability of the application to provide evidence against the action/ transaction that has been done is High.
5	81% - 100%	Ability of the application to provide evidence against the action/ transaction that has been done is Very High.

Table 3.38. Below is indicator of Accountability sub characteristic.

Table 3.38: Indicator of Accountability Sub Characteristic

Level	Indicator	Description
1	0% - 20%	Ability of application to track activities of user is Very Low.
2	21% - 40%	Ability of application to track activities of user is Low.
3	41% - 60%	Ability of application to track activities of user is Moderate.
4	61% - 80%	Ability of application to track activities of user is High.
5	81% - 100%	Ability of application to track activities of user is Very High.

Table 3.39. Below is indicator of Authenticity sub characteristic.

Table 3.39: Indicator of Authenticity Sub Characteristic

Level	Indicator	Description
1	0% - 20%	Ability of application to provide confirmation the authenticity of user data is Very Low.
2	21% - 40%	Ability of application to provide confirmation the authenticity of user data is Low.
3	41% - 60%	Ability of application to provide confirmation the authenticity of user data is Moderate.
4	61% - 80%	Ability of application to provide confirmation the authenticity of user data is High.
5	81% - 100%	Ability of application to provide confirmation the authenticity of user data is Very High.

3.2.4.7 Indicator of Sub Characteristic in Quality in Use Dimension

Design indicator of sub chacteristic in Quality in Use dimension is done the same as the design indicator of Usability characteristic in Product Quality dimension. The stages are also similar, is to test validity and reliability of questionnaire statement which distributed to 30 respondents then analyzed the responses and compared with score interpretation table as indicator of Usability characteristic.

3.2.5 Calculation of Application Quality Value

Calculation quality value of Bukalapak and Tokopedia web application is done by calculating value of each characteristic of ISO 25010 Quality Model. Value of each characteristic is obtained from calculation of total sub characteristic value. Calculation of total sub characteristic value is as described in the previous section. After that the sub characteristic value of the observation or the questionnaire is indicated by the level of indicator, the value of level is calculated by sub characteristic weight to see whether the result of calculation is equal to the weight or lower than to the weight. Sub characteristic value is obtained by the following formula.

$$Value\ SC_n = W_n x \frac{L_n}{MaxL}$$

$Where$:

$Value\ SC_n = Value\ of\ sub\ characteristic\ of\ -n$

$W_n = Weight\ from\ sub\ characteristic\ of\ -n$

$L_n = Level\ from\ observation\ result/\ questionnaire\ of\ sub\ characteristic$

$MaxL = Highest\ level\ for\ each\ indicator\ of\ sub\ characteristic\ (MaxL = 5)$

After that value of each sub characteristic is summed to get the value of characteristic ISO 25010 Quality Model both on Product Quality dimension and Quality in Use dimension. Calculation of each characteristic is obtained by following formula.

$$Value\ SC_n = \sum Value\ SC_n$$

$$\sum Value\ SC_n = Value\ SC_1 + Value\ SC_2 + ... + Value\ SC_n$$

$Where:$

$Value\ SC_n = Characteristic\ value\ of\ -n$

After having value of each characteristic, then all of characteristic value is calculated with this following formula.

$$T\ Value\ C = \sum Value\ C_n$$

$$\sum T\ Value\ C = Value\ C_1 + Value\ C_2 + ... + Value\ C_n$$

$Where:$

$T\ Value\ C_n = Total\ characteristic\ value$

Total characteristic value becomes quantitative value of Bukalapak and Tokopedia web application.

Chapter 4

RESULT AND ANALYSIS

4.1 Result of Adjustment ISO 25010 Quality Model

The first step in this research is to adjust ISO 25010 Quality model with the needs of the research objects, Bukalapak and Tokopedia web application. The result of the quality testing of Bukalapak and Tokopedia web application will be done with six characteristics, they are Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability and Security and 23 sub characteristics namely Functional Completeness, Functional Correctness, Functional Appropriateness, Time Behavior, Resource Utilization, Capacity, Co-Existence, Interoperability, Appropriateness Recognisability, Learnability, Operability, User Error Protection, User Interface Aesthetics, Accessibility, Maturity, Availability, Fault Tolerance, Recoverability, Confidentiality, Integrity, Non-Repudiation, Accountability and Authenticity from Product Quality Dimension and five characteristics, they are Effectiveness, Efficiency, Freedom from Risk, Satisfaction and Context Coverage and nine sub subcharacteristics namely Economic Risk Mitigation, Health and Safety Risk Mitigation, Environmental Risk Mitigation, Usefulness, Trust, Pleasure, Comfort, Context Completeness and Flexibility from Quality in Use Dimension.

4.2 Result of Weighting Characteristics Using AHP Method

After getting the result of adjustment ISO 25010 Quality Model of Bukalapak and Tokopedia web application, the next step is to get result of weighting characteristics from both dimensions. Determination of characteristics and sub characteristics weights was done by distributing questionnaires to 30 respondents and have the results. Table 4.1. Below is characteristics comparison result of Product Quality Dimension.

Table 4.1: Comparison Result of Characteristics in Product Quality Dimension

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Functional Suitability	1	Equal Importance	Performance Efficiency
2	Functional Suitability	5	Strong Importance	Compatibility
3	Functional Suitability	1	Equal Importance	Usability
4	Functional Suitability	1	Equal Importance	Reliability
5	Functional Suitability	1	Equal Importance	Security
6	Performance Efficiency	5	Strong Importance	Compatibility
7	Performance Efficiency	1	Equal Importance	Usability
8	Performance Efficiency	3	Moderate Importance	Reliability
9	Security	1	Equal Importance	Performance Efficiency
10	Compatibility	1	Equal Importance	Usability
11	Compatibility	1	Equal Importance	Reliability
12	Security	1	Equal Importance	Compatibility
13	Usability	1	Equal Importance	Reliability
14	Usability	1	Equal Importance	Security
15	Reliability	1	Equal Importance	Security

Table 4.1. Above shows that pairwise characteristics comparison results of Product Quality Dimension have got the result. Here is the process of weighting use AHP Calculator tools through http://bpmsg.com/academic/ahp_calc.php.

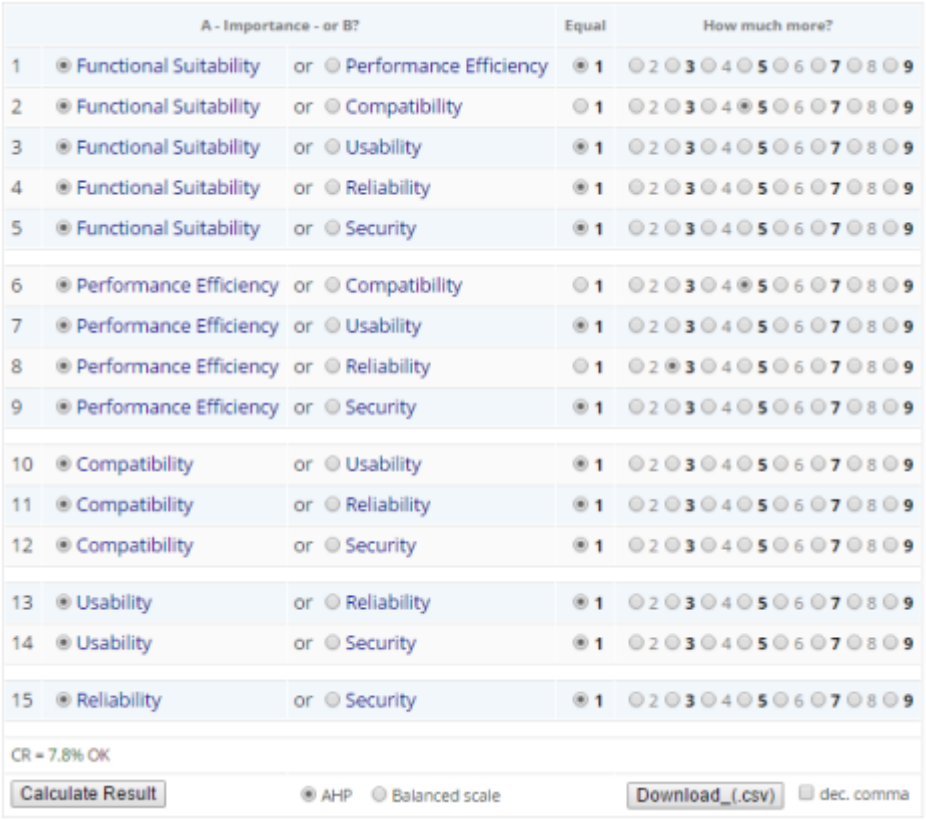


Figure 4.1: Weight Comparison Process of Product Quality Dimension in ISO 25010 Quality Model

Consistency Ratio (CR) that shows on Figure 4.1. Above got 7,8% for characteristics in Product Quality Dimension of ISO 25010. It shows that the pairing comparison answered by respondents are consistent, so the result of sorting could be trusted. The priority result of weighting and decision matrix on Product Quality characteristics of ISO 25010 can be seen on Figure 4.2. Below.

Figure 4.2: Weighting Priority Ranking and Decision Matrix of Product Quality Characteristics ISO 25010

Figure 4.2. Above shows that weighting priority generates the order of Product Quality characteristics from the highest to the lowest. The highest rank is on Performance Efficiency characteristics with priority percentage 25.3%. Characteristic Functional Suitability has 21.4% which is in second rank. Security and Usability characteristics have the same priority percentage that is equal to 15.4% so that they are in third and fourth rank. Next fifth rank is Reliability characteristic with priority percentage 12,8%. While at the lowest rank is the sixth characteristic of Compatibility with priority percentage 9.7%. So, the priority rank on Product Quality characteristics from the highest to the lowest are Performance Efficiency, Functional Suitability, Security, Usability, Reliability and Compatibility. The weighting result can be seen in the Table 4.2. Below.

Table 4.2: Weighting Priority Ranking Characteristics of Product Quality Dimension

No	Charactertistic	Relative Weight	Ranking
1	Performance Efficiency	25.3%	1
2	Functional Suitability	21.4%	2
3	Security	15.4%	3
4	Usability	15.4%	4
5	Reliability	12.8%	5
6	Compatibility	9.7%	6

After weighting the characteristics of Product Quality dimension, the next step is to weight the characteristics of Quality in Use dimension. The process is same as previous weighting, by getting the first mode of questionnaire

30 respondents then put in paired comparison with the help of tools AHP Calculator. Table 4.3. Below is the result of comparison of Quality in Use dimension characteristics.

Table 4.3: Comparison Result of Characteristics in Quality in Use Dimension

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Effectiveness	1	Equal Importance	Efficiency
2	Effectiveness	1	Equal Importance	Satisfaction
3	Effectiveness	2	Intermediate Values	Freedom from Risk
4	Effectiveness	2	Intermediate Values	Context Coverage
5	Efficiency	1	Equal Importance	Satisfaction
6	Efficiency	1	Equal Importance	Freedom from Risk
7	Efficiency	2	Intermediate Values	Context Coverage
8	Satisfaction	1	Equal Importance	Freedom from Risk
9	Satisfaction	3	Moderate Importance	Context Coverage
10	Freedom from Risk	3	Moderate Importance	Context Coverage

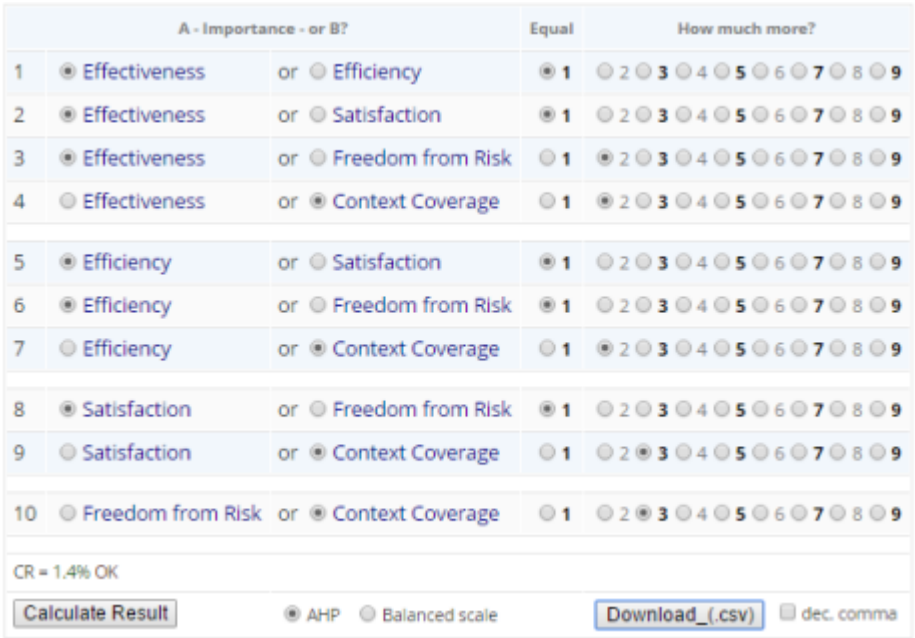


Figure 4.3: Weight Comparison Process of Quality in Use Dimension in ISO 25010 Quality Model

Figure 4.3. Above shows the value of Consistency Ratio (CR) in the dimension of Quality in Use is 1.4% indicating that the questionnaire filled by 30 respondents consistent. Consistency shows reliable results for weighting Quality in Use dimension. Figure 4.4. Below are weighting priority and the decision matrix on Quality in Use Characteristics.

Figure 4.4: Weighting Priority Ranking and Decision Matrix of Characteristic Quality in Use ISO 25010

Figure 4.4. Above shows the weighting priority generates the order of Quality in Use Charcteristics from the highest to the lowest. The highest rank is on Context Coverage Characteristic with priority percentage of 37.6%. Effectiveness Characteristic has a percentage of 18.6% in second rank. Efficiency Characteristic has a priority percentage of 160% which is in the third rank. On the fourth priority is Satisfaction Characteristic with priority percentage of 14.8%. On the lowest priority is the fifth Freedom from Risk Characteristic with priority percentage of 13.0%. The priority ranking on Characteristic Quality in Use from the highest to the lowest are Context Completeness, Effectiveness, Efficiency, Satisfaction and Freedom from Risk or can be seen in the following Table 4.4. Below.

Table 4.4: Weighting Priority Ranking Characteristics of Quality in Use Dimension

No	Charactertistic	Relative Weight	Ranking
1	Context Completeness	37.6%	1
2	Effectiveness	18.6%	2
3	Efficiency	16.0%	3
4	Satisfaction	14.8%	4
5	Freedom from Risk	13.0%	5

4.3 Weighting Adjustment Result of Sub Characteristic Using AHP Method

After having the weighting result from each Characteristic of ISO 25010 dimension, then the next step is weight determination of sub Characteristic.

Sub Characteristics are Functional Completeness, Functional Correctness, Functional Appropriateness, Time Behavior, Resource Utilization, Capacity, Co-Existence, Interoperability, Appropriateness Recognizability, Learnability, Operability, User Error Protection, User Interface Aesthetics, Accessibility, Fault Tolerance, Recoverability, Confidentiality, Integrity, Non-Repudiation, Accountability, Authenticity, Modularity, Reactivity, Analyzability, Modifiability, Testability, Adaptability, Installability, and Replaceability from Product Quality Dimension and Usefulness, Trust, Pleasure, Comfort, Economic Risk Mitigation, Health And Safety Risk Mitigation , Environmental Risk Mitigation, Context Completeness and Flexibility from Quality in Use dimension. Here are the more detailed steps weight determination of each sub characteristic.

4.3.1 Weighting Adjustment Result of Sub Characteristic in Characteristic Product Quality Dimension

ISO 25010 Quality Model has two dimensions of quality measurement, that is Product Quality and Quality in Use. Characteristic which will be determined its weight on Product Quality Dimension of eight Characteristic and 31 Characteristic. Here is the result of weighting each sub Characteristic on Product Quality dimension.

4.3.1.1 Weighting Adjustment Result of Sub Characteristic in Functional Suitability Characteristic Using AHP Method

Weight determination of ISO 25010 Quality Model begins with weighting determination of sub characteristic in Functional Suitability characteristic. Sub Characteristic on Functional Suitability characteristic are Functional Correctness, Functional Completeness and Functional Appropriateness. Table 4.5. Below are the pariwise comparison results of sub characteristic in Functional Suitability Characteristic based on result of questionnaire by 30 respondents.

Table 4.5: Pairwise Comparison Result of Sub Characteristic in Functional Suitability Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Functional Correctness	7	Very Strong Importance	Functional Completeness
2	Functional Appropriateness	9	Extreme Importance	Functional Completeness
3	Functional Appropriateness	3	Moderate Importance	Functional Correctness

Table 4.5. Above is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.5. Below is the weighting comparison process of subcharacteristic in Functional Suitability characteristic.

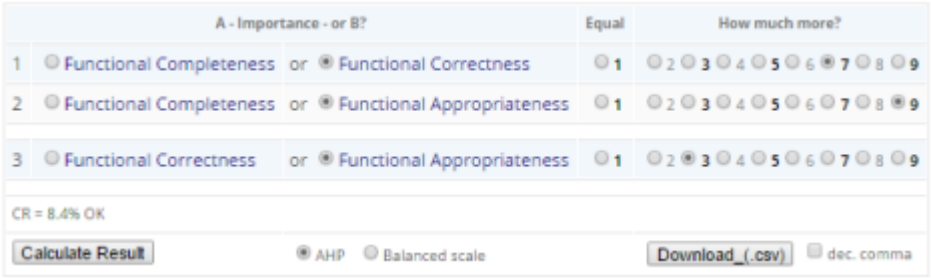


Figure 4.5: Weighting Comparison Process of Sub Characteristic in Functional Suitability Characteristic

Figure 4.5. Above shows the value of Consistency Ratio (CR) on Sub Characteristic in Functional Suitability characteristic of 8.4%. The percentage holds that the response given by the respondent is consistent. Figure 4.6. Below are weighting priority and the decision matrix of sub characteristic in Functional Suitability Characteristic.

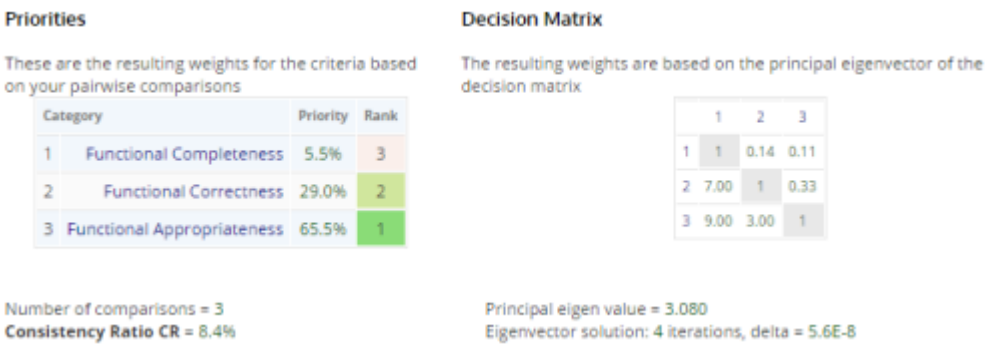


Figure 4.6: Weighting Priority Ranking and Decision Matrix of Sub Characteristic in Functional Suitability Characteristic

Figure 4.6. Above shows the weighting priority generates the order of sub characteristic in Functional suitability characteristic from the highest to the lowest. The highest rank is on Functional Appropriateness with priority percentage of 65.5%. The second and third rank is Functional Correctness with 29.0% and Functional Completeness with 5.5% of priority percentage.

4.3.1.2 Weighting Adjustment Result of Sub Characteristic in Performance Effieciency Characteristic

Weighting adjustment of sub characteristic in Performance Efficiency characteristic is done by three sub charactertics, Time Behavior, Resource Utilization and Capacity. Based on questionnaire by 30 respondents, is obtained the pairwise comparison results of sub characteristic in Performance Efficiency characteristic on Table 4.6. below.

Table 4.6: Pairwise Comparison Result of Sub Characteristic in Performance Efficiency Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Time Behavior	3	Moderate Importance	Resource Utilization
2	Time Behavior	5	Strong Importance	Capacity
3	Resource Utilization	3	Moderate Importance	Capacity

Table 4.6. Above shows the pairwise comparison results of sub characteristic in Performance Efficiency characteristic. The result is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.7. Below is the weighting comparison process of subcharacteristic in Performance Efficiency characteristic.

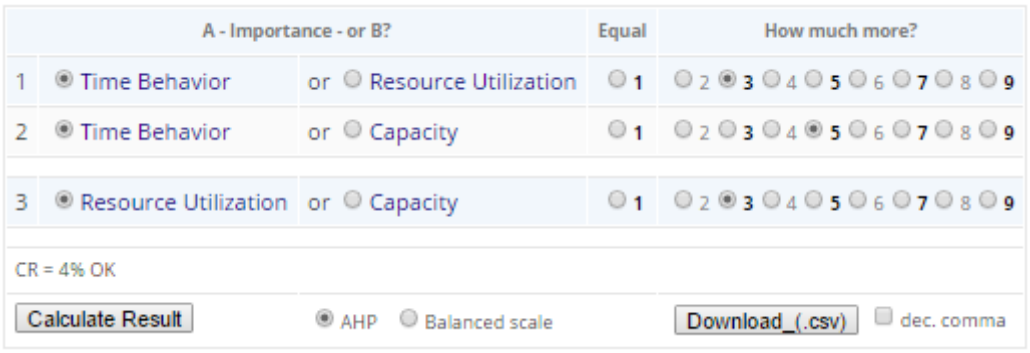


Figure 4.7: Weighting Comparison Process of Sub Characteristic in Performance Efficiency Characteristic

Figure 4.7. Above shows the value of Consistency Ratio (CR) on sub characteristic in Performance Efficiency characteristic of 8.4%. The percentage holds that the response given by the respondent is consistent. Figure 4.7. Below are weighting priority and the decision matrix of sub characteristic in Performance Efficiency characteristic.

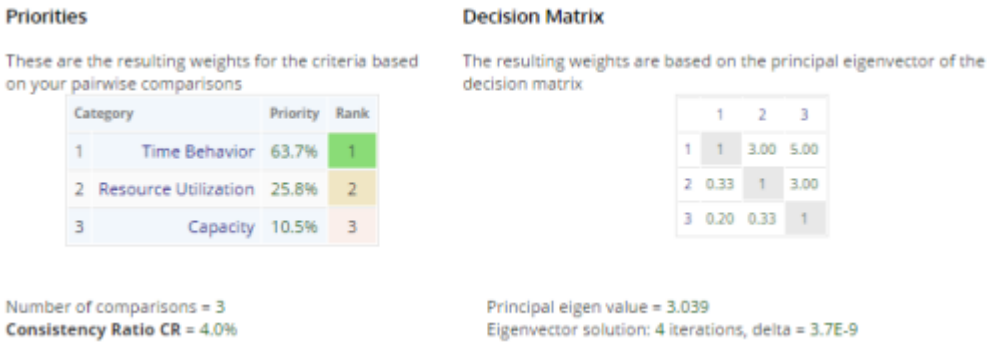


Figure 4.8: Weighting Priority Ranking and Matrix of Sub Characteristic in Performance Efficiency Characteristic

Figure 4.8. Above shows the weighting priority generates the order of sub characteristic in Performance Efficiency characteristic from the highest to the lowest. The highest rank is on Time Behavior with priority percentage of 63.7%. The second and third rank is Resource Utilization with 25.8% and Capacity with 10.5% of priority percentage.

4.3.1.3 Weighting Adjustment Result of Sub Characteristic in Compatibility Characteristic

Weighting adjustment of sub characteristic in Compatibility characteristic is obtained by its two sub characteristics, Co-Existence and Interoperability. Based on questionnaire by 30 respondents, is obtained the pairwise comparison results of sub characteristic in Compatibility characteristic on Table 4.7. Below.

Table 4.7: Pairwise Comparison Result of Sub Characteristic in Compatibility Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Interoperability	5	Strong Importance	Co-Existence

Table 4.7. Above shows the pairwise comparison results of sub characteristic in Compatibility characteristic. The result is used to obtain Weighting

Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.9. Below is the weighting comparison process of subcharacteristic in Compatibility characteristic.

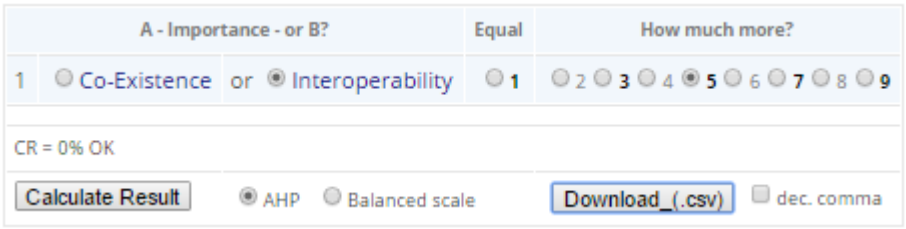


Figure 4.9: Weighting Comparison Process of Sub Characteristic in Compatibility Characteristic

Figure 4.9. Above shows the value of Consistency Ratio (CR) on sub characteristic in Compatibility characteristic of 0%. The percentage holds that the response given by the respondent is very consistent that the result can be trusted. Figure 4.10. Below are weighting priority and the decision matrix of sub characteristic in Compatibility characteristic.

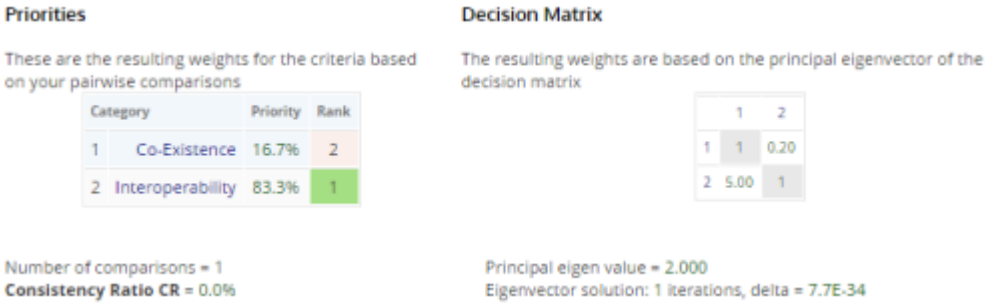


Figure 4.10: Weighting Priority Ranking and Matrix of Sub Characteristic in Compatibility Characteristic

Figure 4.10. Above shows the weighting priority generates the order of sub characteristic in Compatibility characteristic from the highest to the lowest. The highest rank is on Interoperability with priority percentage of 83.3% and the second rank is Co-Existence with 10.5% of priority percentage.

4.3.1.4 Weighting Adjustment Result of Sub Characteristic in Usability Characteristic

Weighting adjustment of sub characteristic in Usability characteristic is obtained by its six sub characteristics, Appropriateness Recognisability, Learnability, Operability, User Error Protection, User Interface Aesthetics and

Accessability. Based on questionnaire by 30 respondents, is obtained the pairwise comparison results of sub characteristic in Usability characteristic on Table 4.8. Below.

Table 4.8: Pairwise Comparison Result of Sub Characteristic in Usability Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Learnability	3	Moderate Importance	Appropriateness Recognisability
2	Operability	2	Intermediate Values	Appropriateness Recognisability
3	User Error Protection	5	Strong Importance	Appropriateness Recognisability
4	User Interface Aesthetics	5	Strong Importance	Appropriateness Recognisability
5	Accessibility	3	Moderate Importance	Appropriateness Recognisability
6	Operability	1	Equal Importance	Learnability
7	Learnability	3	Moderate Importance	User Error Protection
8	Learnability	3	Moderate Importance	User Interface Aesthetics
9	Accessibility	1	Equal Importance	Learnability
10	Operability	1	Equal Importance	User Error Protection
11	Operability	1	Equal Importance	User Interface Aesthetics
12	Operability	1	Equal Importance	Accessibility
13	User Error Protection	1	Equal Importance	User Interface Aesthetics
14	Accessibility	3	Moderate Importance	User Error Protection
15	Accessibility	3	Moderate Importance	User Interface Aesthetics

Table 4.8. Above shows the pairwise comparison results of sub characteristic in Usability characteristic. The result is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.11. Below is the weighting comparison process of sub characteristic in Usability characteristic.

Figure 4.11: Weighting Comparison Process of Sub Characteristic in Usability Characteristic

Figure 4.11. Above shows the value of Consistency Ratio (CR) on sub characteristic in Usability characteristic of 7.9%. The percentage holds that the response given by the respondent is still consistent that the result still can be trusted. Figure 4.12. Below are weighting priority and the decision matrix of sub characteristic in Usability characteristic.

Figure 4.12: Weighting Priority Ranking and Matrix of Sub Characteristic in Usability Characteristic

Figure 4.12. Above shows the weighting priority generates the order of sub characteristic in Usability characteristic from the highest to the lowest. The highest rank is on Accessibility and Learnability with same priority percentage of 25.5%. The next rank is on Operability with priority percentage of 16.3%. User Error Protection and User Interface Aesthetics also has the same priority percentage of 13.6%. In the last rank is Appropriateness Recognisability sub characteristic with prirority percentage of 5.6 %.

4.3.1.5 Weighting Adjustment Result of Sub Characteristic in Reliability Characteristic

Weighting adjustment of sub characteristic in Reliability characteristic is obtained by its four sub characteristics, Maturity, Availability, Fault Tolerance and Recoverability. Based on questionnaire by 30 respondents, is obtained the pairwise comparison results of sub characteristic in Reliability characteristic on Table 4.9. Below.

Table 4.9: Pairwise Comparison Result of Sub Characteristic in Reliability Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Availability	3	Moderate Importance	Maturity
2	Maturity	3	Moderate Importance	Fault Tolerance
3	Recoverability	7	Very Strong Importance	Maturity
4	Availability	5	Strong Importance	Fault Tolerance
5	Recoverability	5	Strong Importance	Availability
6	Recoverability	7	Very Strong Importance	Fault Tolerance

Table 4.9. Above shows the pairwise comparison results of sub characteristic in Reliability characteristic. The result is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.13. Below is the weighting comparison process of sub characteristic in Reliability characteristic.

Figure 4.13: Weighting Comparison Process of Sub Characteristic in Reliability Characteristic

Figure 4.13. Above shows the value of Consistency Ratio (CR) on sub characteristic in Reliability characteristic of 8.8%. The percentage holds that the response given by the respondent is still consistent that the result still can be trusted. Figure 4.14. Below are weighting priority and the decision matrix of sub characteristic in Reliability characteristic.

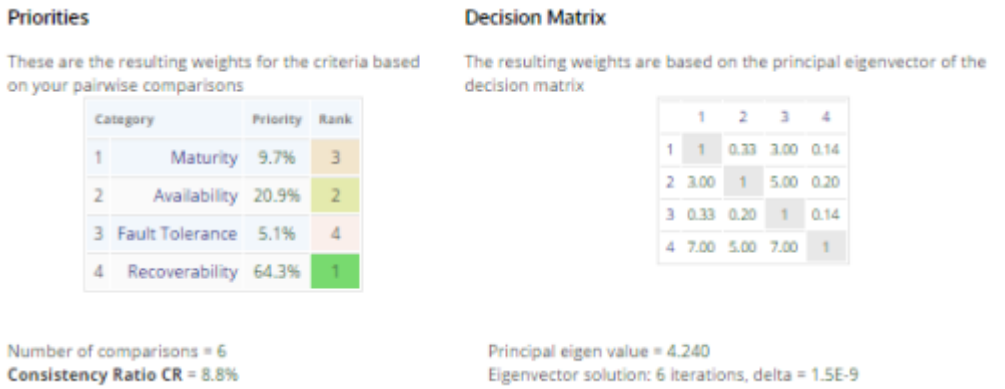


Figure 4.14: Weighting Priority Ranking and Matrix of Sub Characteristic in Reliability Characteristic

Figure 4.14. Above shows the weighting priority generates the order of sub characteristic in Reliability characteristic from the highest to the lowest. The highest rank is on Recoverability with priority percentage of 64.3%. The second rank is Availability with priority percentage of 20.9%. Maturity and Fault Tolerance sub characteristic with priority percentage of 9,7 % and 5,1 %.

4.3.1.6 Weighting Adjustment Result of Sub Characteristic in Security Characteristic

Weighting adjustment of sub characteristic in Usability characteristic is obtained by its five sub characteristics, Confidentiality, Integrity, Non-repudiation, Accountability and Authenticity. Based on questionnaire by 30 respondents, is obtained the pairwise comparison results of sub characteristic in Security characteristic on Table 4.10. below.

Table 4.10: Pairwise Comparison Result of Sub Characteristic in Security Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Confidentiality	1	Equal Importance	Integrity
2	Confidentiality	3	Moderate Importance	Non-repudiation
3	Confidentiality	3	ModerateImportance	Accountability
4	Confidentiality	3	ModerateImportance	Authenticity
5	Integrity	7	Very Strong Importance	Non-repudiation
6	Integrity	3	Moderate Importance	Accountability
7	Integrity	1	Equal Importance	Authenticity
8	Non-repudiation	1	Equal Importance	Accountability
9	Non-repudiation	1	Equal Importance	Authenticity
10	Authenticity	3	Moderate Importance	Accountability

Table 4.10. Above shows the pairwise comparison results of sub characteristic in Security characteristic. The result is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.15. Below is the weighting comparison process of sub characteristic in Security characteristic.

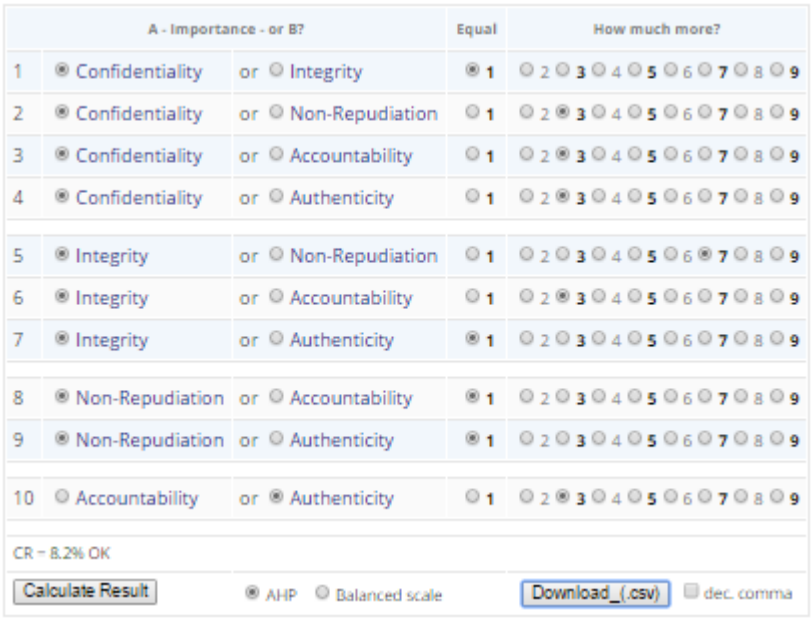
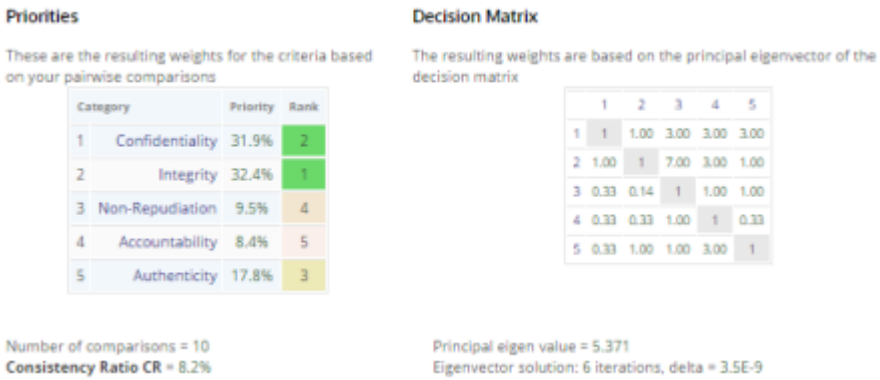


Figure 4.15: Weighting Comparison Process of Sub Characteristic in Security Characteristic

Figure 4.15. Above shows the value of Consistency Ratio (CR) on sub characteristic in Security characteristic of 8.2%. The percentage holds that the response given by the respondent is still consistent that the result still

can be trusted. Figure 4.16. Below are weighting priority and the decision matrix of sub characteristic in Security characteristic.



Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Confidentiality	31.9%	2
2	Integrity	32.4%	1
3	Non-Repudiation	9.5%	4
4	Accountability	8.4%	5
5	Authenticity	17.8%	3

Number of comparisons = 10
Consistency Ratio CR = 8.2%

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5
1	1	1.00	3.00	3.00	3.00
2	1.00	1	7.00	3.00	1.00
3	0.33	0.14	1	1.00	1.00
4	0.33	0.33	1.00	1	0.33
5	0.33	1.00	1.00	3.00	1

Principal eigen value = 5.371
Eigenvector solution: 6 iterations, delta = 3.5E-9

Figure 4.16: Weighting Priority Ranking and Matrix of Sub Characteristic in Security Characteristic

Figure 4.16. Above shows the weighting priority generates the order of sub characteristic in Security characteristic from the highest to the lowest. The highest rank is on Integrity with priority percentage of 32.4%. The second and third rank is Confidentiality with 31.9% and Authenticity with 17.8% of priority percentage. Non-Repudiation and Accountability sub characteristic with 9,5 % and 8,4 % of priority percentages.

Table 4.11. Below is summary of weighting all sub characteristics result of Product Quality dimension.

Table 4.11: Weighting Sub Characteristics of Product Quality Dimension

Characteristic	Relative Weight of Characteristic	Sub Characteristic	Relative Weight of Sub Characteristic	Relative Weight of Sub Characteristic (based on characteristic weight)
Functional Suitability	21.4%	Functional Completeness	5.5%	1.18%
		Functional Correctness	29.0%	6.21%
		Functional Appropriateness	65.5%	14.02%
Performance Efficiency	25.3%	Time Behavior	63.7%	16.12%
		Resource Utilization	25.8%	6.53%
		Capacity	10.5%	2.66%
Compatibility	9.7%	Co-Existence	16.7%	1.62%
		Interoperability	83.3%	8.08%
Usability	15.4%	Appropriateness Recognizability	5.6%	0.86%
		Learnability	25.5%	3.93%
		Operability	16.3%	2.51%
		User Error Protection	13.6%	2.09%
		User Interface Aesthetics	13.6%	2.09%
		Accessibility	25.5%	3.93%
Reliability	12.8%	Maturity	9.7%	1.24%
		Availability	20.9%	2.68%
		Fault Tolerance	5.1%	0.65%
		Recoverability	64.3%	8.23%
Security	15.4%	Integrity	32.4%	4.99%
		Confidentiality	31.9%	4.91%
		Authenticity	17.8%	2.74%
		Non-Repudiation	9.5%	1.46%
		Accountability	8.4%	1.29%

4.3.2 Weighting Adjustment Result of Sub Characteristic in Characteristic Quality in Use Dimension

After having the result of weighting adjustment of characteristic in Product Quality dimension, then the same stages to characteristic in Quality in Use dimension. Quality in Use dimension has five characteristics, Effectiveness, Efficiency, Context Coverage, Freedom from Risk and Satisfaction. However, in this weighting adjustment is only obtained by three characteristics, Context Coverage, Freedom from Risk and Satisfaction. This is because Effectiveness and Efficiency characteristic does not have sub characteristic so it can not be calculated to the weight of its sub characteristic.

4.3.2.1 Weighting Adjustment Result of Sub Characteristic in Context Coverage Characteristic

Weighting adjustment of sub characteristic in Context Coverage characteristic is obtained by its two sub characteristics, Context Completeness and Flexibility. Based on questionnaire by 30 respondents, is obtained the pairwise comparison results of sub characteristic in Context Coverage characteristic on Table 4.12. Below.

Table 4.12: Pairwise Comparison Result of Sub Characteristic in Context Coverage Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Context Completeness	7	Very Strong Importance	Flexibility

Table 4.12. Above shows the pairwise comparison results of sub characteristic in Context Coverage characteristic. The result is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.17. Below is the weighting comparison process of sub characteristic in Context Coverage characteristic.

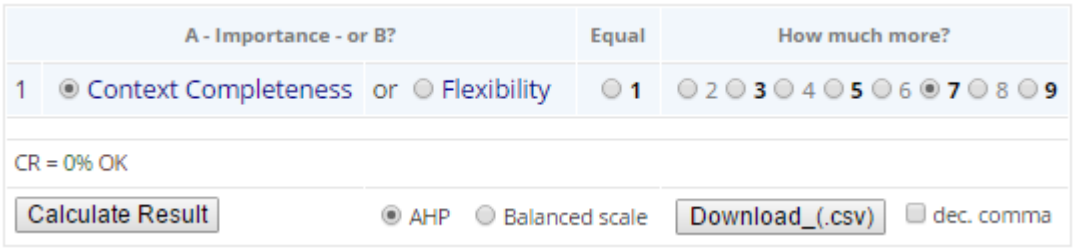


Figure 4.17: Weighting Comparison Process of Sub Characteristic in Context Coverage Characteristic

Figure 4.17. Above shows the value of Consistency Ratio (CR) on sub characteristic in Context Coverage characteristic of 0%. The percentage holds that the response given by the respondent is very consistent that the result can be trusted. Figure 4.18. Below are weighting priority and the decision matrix of sub characteristic in Context Coverage characteristic.

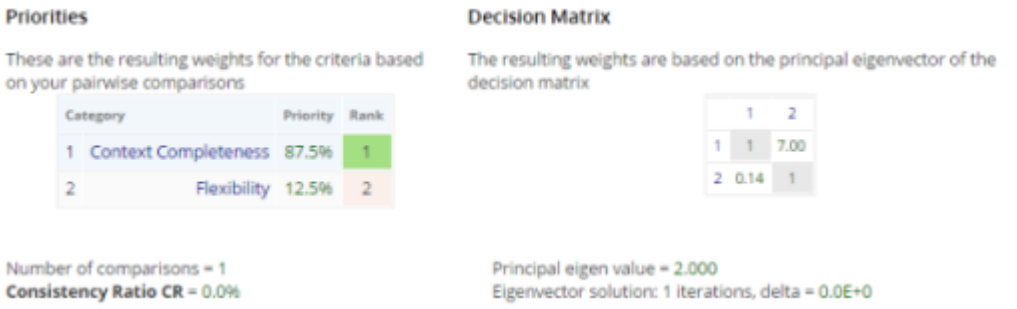


Figure 4.18: Weighting Priority Ranking and Matrix of Sub Characteristic in Context Coverage Characteristic

Figure 4.18. Above shows the weighting priority generates the order of sub characteristic in Context Coverage characteristic from the highest to the lowest. The highest rank is on Context Completeness with priority percentage of 87.5% and the lowest rank is Flexibility with 12.5%.

4.3.2.2 Weighting Adjustment Result of Sub Characteristic in Freedom from Risk Characteristic

Weighting adjustment of sub characteristic in Freedom from Risk characteristic is obtained by its three sub characteristics, Economic Risk Mitigation, Health anAud Safety Risk Mitigation and Environmental Mitigation. Based on questionnaire by 30 respondents, is obtained the pairwise comparison results of sub characteristic in Freedom from Risk characteristic on the following Table 4.13. Below.

Table 4.13: Pairwise Comparison Result of Sub Characteristic in Freedom from Risk Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Economic Risk Mitigation	3	Moderate Importance	Health and Safety Risk Mitigation
2	Economic Risk Mitigation	5	Strong Importance	Environmental Mitigation
3	Health and Safety Risk Mitigation	3	Moderate Importance	Environmental Mitigation

Table 4.13. Above shows the pairwise comparison results of sub characteristic in Freedom from Risk characteristic. The result is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.19. Below is the weighting comparison process of subcharacteristic in Freedom from Risk characteristic.

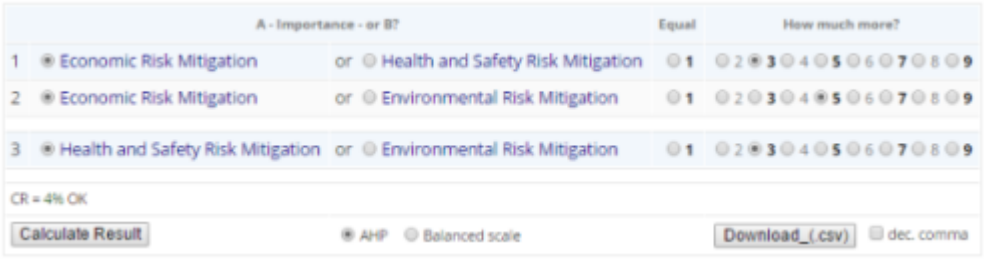


Figure 4.19: Weighting Comparison Process of Sub Characteristic in Freedom from Risk Characteristic

Figure 4.19. Above shows the value of Consistency Ratio (CR) on sub characteristic in Freedom from Risk characteristic of 4%. The percentage holds that the response given by the respondent is consistent that the result can be trusted. Figure 4.20. Below are weighting priority and the decision matrix of sub characteristic in Freedom from Risk characteristic.

Figure 4.20: Weighting Priority Ranking and Matrix of Sub Characteristic in Freedom from Risk Characteristic

Figure 4.20. Above shows the weighting priority generates the order of sub characteristic in Freedom from Risk characteristic from the highest to the lowest. The highest rank is on Economic Risk Mitigation with priority percentage of 63.7%. The second rank is Health and Safety Risk Mitigation with 25.8% and the lowest rank is Environmental Risk Mitigation with 10.5% of priority percentage.

4.3.2.3 Weighting Adjustment Result of Sub Characteristic in Satisfaction Characteristic

Weighting adjustment of sub characteristic in Satisfaction characteristic is obtained by its four sub characteristics, Trust, Usefulness, Pleasure and Comfort. Based on questionnaire by 30 respondents, is obtained the pairwise

comparison results of sub characteristic in Satisfaction characteristic on Table 4.14. Below.

Table 4.14: Pairwise Comparison Result of Sub Characteristic in Satisfaction Characteristic

No	Element-1	Comparison		Element-2
		Scale	Definition	
1	Trust	3	Moderate Importance	Usefulness
2	Usefulness	5	Strong Importance	Pleasure
3	Usefulness	3	Moderate Importance	Comfort
4	Trust	5	Strong Importance	Pleasure
5	Trust	5	Strong Importance	Comfort
6	Pleasure	3	Moderate Importance	Comfort

Table 4.14. Above shows the pairwise comparison results of sub characteristic in Satisfaction characteristic. The result is used to obtain Weighting Priority Ranking and Decision Matrix by using AHP Calculator tools. Figure 4.21. Below is the weighting comparison process of sub characteristic in Satisfaction characteristic.

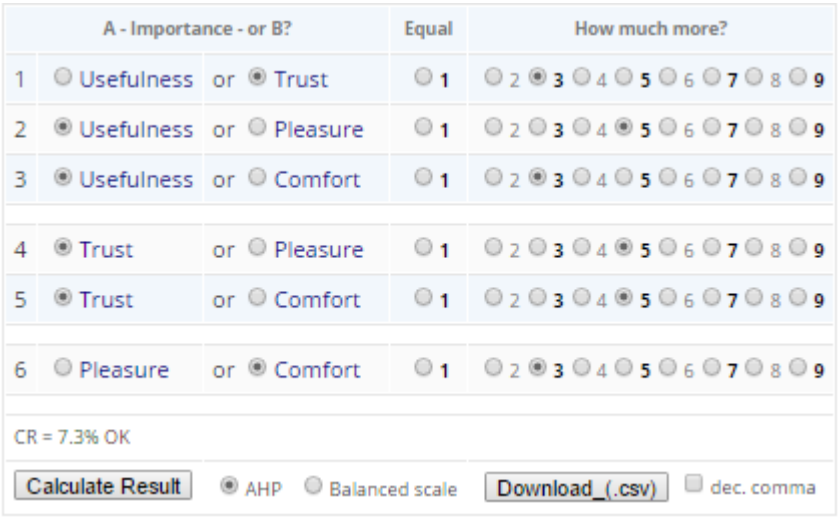


Figure 4.21: Weighting Comparison Process of Sub Characteristic in Satisfaction Characteristic

Figure 4.21. Above shows the value of Consistency Ratio (CR) on sub characteristic in Satisfaction characteristic of 7.3%. The percentage holds that the response given by the respondent is still consistent that the result still can be trusted. Figure 4.22. Below are weighting priority and the decision matrix of sub characteristic in Satisfaction characteristic.

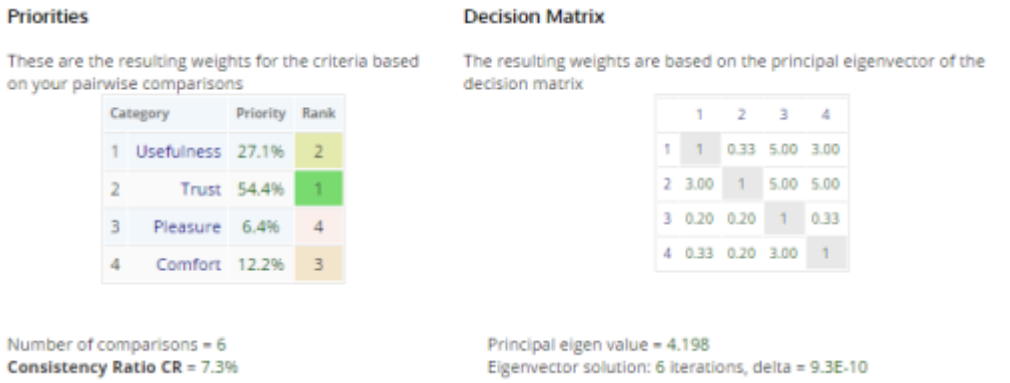


Figure 4.22: Weighting Priority Ranking and Matrix of Sub Characteristic in Satisfaction Characteristic

Figure 4.22. Above shows the weighting priority generates the order of sub characteristic in Satisfaction characteristic from the highest to the lowest. The highest rank is on Trust with priority percentage of 54.4%. The second rank is Usefulness with 25.8%. The third and the lowest rank is Comfort and Pleasure with 12.2% and 6.4% of priority percentages.

Table 4.15 Below is the summary of weighting all sub characteristics result in Quality in Use dimension.

Table 4.15: Weighting Sub Characteristics of Quality in Use Dimension

Characteristic	Relative Weight of Characteristic	Sub Characteristic	Relative Weight of Sub Characteristic	Relative Weight of Sub Characteristic (based on characteristic weight)
Effectiveness	18.6%	Effectiveness	18.6%	18.6%
Efficiency	16.0%	Efficiency	16.0%	16.0%
Satisfaction	14.8%	Usefulness	27.1%	4.01%
		Trust	54.4%	8.05%
		Pleasure	6.4%	0.95%
		Comfort	12.2%	1.81%
Freedom from Risk	13.0%	Economic Risk Mitigation	63.7%	8.28%
		Environmental Risk Mitigation	10.5%	1.37%
		Health and Safety Risk Mitigation	25.8%	3.35%
Context Coverage	21.4%	Context Completeness	87.5%	18.73%
		Flexibility	12.5%	2.67%

Based on the research has been done on the weight of each characteristic and sub characteristic of ISO 25010 Quality Model obtained the results of

characteristic and sub characteristic from the dominant that can be seen in following Table 4.16. Below.

Table 4.16: Prority Ranking Sub Characteristics of Product Quality Dimension

No	Charactertistic	Relative Weight	Ranking
2.1	Time Behavior	16.12%	1
1.3	Functional Appropriateness	14.02%	2
5.4.	Recoverability	8.23%	3
3.2.	Interoperability	8.08%	4
2.2.	Resource Utilization	6.53%	5
1.2.	Functional Correctness	6.21%	6
3.2.	Confidentiality	4.91%	7
3.1.	Integrity	4.99%	8
4.2.	Learnabilty	3.93%	9
4.6.	Accessibility	3.93%	10
3.3.	Authenticity	2.74%	11
5.2.	Avalability	2.68%	12
2.3.	Capacity	2.66%	13
4.3.	Operability	2.51%	14
4.4.	User Error Protection	2.09%	15
4.5.	User Interface Aesthetics	2.09%	16
3.1.	Co-Existence	1.62%	17
3.4.	Non-Repudiation	1.46%	18
3.5.	Accountability	1.29%	19
5.1.	Maturity	1.24%	20
1.1.	Functional Completeness	1.18%	21
4.1.	Appropriateness Recognizability	0.86%	22
5.3.	Fault Tolerance	0.65%	23

Table 4.17. Below is priority ranking sub characteristic of Quality in Use dimension.

Table 4.17: Prority Ranking Sub Characteristics of Quality in Use Dimension

No	Charactertistic	Relative Weight	Ranking
5.1.	Context Completeness	32.9%	1
1.1.	Effectiveness	18.6%	2
2.1.	Efficiency	16.0%	3
3.2.	Trust	8.05%	4
4.1.	Economic Risk Mitigation	8.28%	5
5.2.	Flexibility	4.70%	6
3.1.	Usefulness	4.01%	7
4.3.	Health and Safety Risk Mitigation	3.35%	8
3.4.	Comfort	1.81%	9
4.2.	Environmental Risk Mitigation	1.37%	10
3.3.	Pleasure	0.95%	11

4.4 Testing of Bukalapak Web Application (www.bukalapak.com)

Bukalapak web application which site www.bukalapak.com is an application that provides buying and selling from consumer to consumer (C2C). Bukalapak web application will be tested for its quality through www.bukalapak.com that accessed on notebook AXIOO neon RNO 14 inch with processor Intel Core i7-3630QM (2.640 GHz), RAM 4 GB, Hardisk 500 GB and Operating System Windows 8.1. (Win 64) using standard of ISO 25010 Quality Model. Here are the test results of each dimension in ISO 25010 Quality Model.

4.4.1 Testing of Characteristic in Product Quality Dimension

Testing of Bukalapak web application through www.bukalapak.com begins with testing the Product Quality dimension. Based on adjustment characteristic and sub characteristic ISO 25010 Quality Model which have been done before, characteristic on Product Quality dimension will be tested is Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability and Security characteristic.

4.4.1.1 Testing of Functional Suitability Characteristic

Testing of Functional Suitability characteristic on bukalapak web application through www.bukalapak.com consists of three sub characteristic assessments, that are Functional Completeness, Functional Correctness and Functional Appropriateness.

1. Functional Completeness Sub Characteristic

   Testing of Functional Completeness sub characteristic on Bukalapak web application (www.bukalapak.com) is obtained using Black Box Testing by an employee as Quality Assurance (QA) in a technology company as a tester. This test is done by observing the completeness of function on Bukalapak website. Table 4.18. Below is Bukalapak web application testing result on functional completeness sub characteristic.

   Table 4.18: Testing Result of Functional Completeness Sub Characteristic on Bukalapak Web Application

No	Test Case	Actual Result
1	Application has registration function as new user.	Yes
2	Application has login function connected to Facebook.	Yes
3	Application has login function connected to Yahoo.	No
4	Application has login function connected to Google.	Yes
5	Application has product category.	Yes
6	Application has search function.	Yes
7	Application has wishlist feature.	Yes
8	Application has rating feature.	Yes
9	Application has filter function of certain categories.	Yes
10	Application has sort function of certain categories.	Yes
11	Application has rating feature to product.	Yes
12	Application has share feature to Line application.	No
13	Application has share feature to Facebook application.	Yes
14	Application has share feature to Twitter application.	Yes
15	Application has share feature to Google+ application.	Yes
16	Application has share feature to Pinterest application.	Yes
17	Application has product specification (product detail information).	Yes
18	Application has seller information.	Yes
19	Application has chat feature.	Yes

20	Application has a feature of providing a review of a product already purchased.	Yes
21	Application has product discussion through Q&A.	No
22	Application has Shopping Cart.	Yes
23	Application has electronic payment system.	Yes
24	Application has help menu.	Yes
25	Application has feature of adding product to sale.	Yes
26	Application has feedback feature.	Yes
27	Application has function to provide notification.	Yes
28	Application has feature to check transaction status.	Yes
29	Application has bargain feature.	Yes
30	Application has refund feature.	No
31	Application has pre-order feature.	No
32	Application has feature to favorite product.	Yes
33	Application has forgot password feature.	Yes
34	Application provide statistics of seller information.	Yes
35	Application has subscription feature.	Yes
36	Application has seller profile setting feature.	Yes
37	Application has feature to upload photos connected to Instagram for seller.	Yes
38	Application has feature to upload photos connected to Facebook for seller.	Yes
39	Application has premium account for seller.	Yes
40	Application has logout menu.	Yes

According to the results of Functional Completeness sub characteristic testing on Bukalapak web application, percentage of Functional Completeness sub characteristic can be determined as follow by the total number of completeness is 40 functions.

$$Yes = \frac{33}{40} x 100\% = 82.5\%$$

$$No = \frac{7}{40} x 100\% = 17.5\%$$

Based on calculation above, the result will be compared with Table 3.22. Indicator of Functional Completeness Sub Characteristic. The result is 82,5% which on level 5 with range 81%-100%. This shows that Bukalapak web applicaton has very good quality in Functional Completeness aspect.

2. Functional Correctness and Functional Appropriateness Sub Characteristic

Testing of Functional Correctness and Functional Appropriateness sub characteristic is obtained with same method on Functional Completeness testing, using Black Box Testing. Tester on this test is same with Functional Completeness testing, an employee as Quality Assurance (QA) in a technology company. Table 4.19. Below is Bukalapak web application testing result on Functional Correctness and Functional Appropriateness sub characteristic.

Table 4.19: Testing Result of Functional Correctness and Functional Appropriateness Sub Characteristic on Bukalapak Web Application

No	Test Case	Actual Result	
		F. Correctness	F. Appropriateness
1	Registration		
a	Input registration data correctly in accordance with registration terms.	Yes	Yes
b	Input registration data incorrectly in accorandce with registration terms.	Yes	Yes
c	Input registration data that have already been registered.	Yes	Yes
2	Login		
a	Input login data correctly.	Yes	Yes
b	Input login data incorrectly.	Yes	Yes
c	Login with correct Facebook account.	Yes	Yes
d	Login with incorrect Facebook account.	Yes	Yes
e	Login with correct Google+ account.	Yes	Yes
f	Login with incorrect Google+ account.	Yes	Yes
g	Login with correct Yahoo account.	No	No
h	Login with incorrect Yahoo account.	No	No
3	Forgot Password		
a	Forgot password when login.	Yes	Yes
4	Select Product Category		
a	Select one product category. Example: Electronic category.	Yes	Yes
b	Filter product by shipment. Example: TIKI	Yes	Yes

c	Filter combination using available	Yes	Yes
	filter that are price range, shipment and location.		
5	Search Product		
a	Search “iPhone SE”	Yes	Yes
6	Select Product		
a	Order product by entering stock quantity exceeds to stock provided by seller.	Yes	Yes
b	Order product by entering stock quantity according to stock provided by seller.	Yes	Yes
c	Sort product with lowest price.	Yes	Yes
d	Sort product with highest price.	Yes	Yes
e	Sort product with relevance.	Yes	Yes
f	Sort product with the newest.	Yes	Yes
g	Press “Buy” button to buy product.	Yes	Yes
7	Shopping Cart		
a	Delete order in shopping cart.	Yes	Yes
b	Change quantity product from shopping cart.	Yes	Yes
8	Rating and Comment		
a	Rating and comment on products previously purchased by users.	Yes	Yes
b	Rating and comment on a product that has never been purchased before by users	Yes	Yes
9	Payment Transaction		
a	Using valid voucher code for payment.	Yes	Yes
b	Using invalid voucher code for payment.	Yes	Yes
c	Transfer payment method and enter correct payment code in accordance with notification.	Yes	Yes
d	Transfer payment method and enter incorrect payment code in accordance with notification.	Yes	Yes
e	Transaction done.	Yes	Yes
10	Wishlist		
a	Select product to wishlist.	Yes	Yes
11	Share Product		
a	Share product to Facebook.	Yes	Yes
b	Share product to Twitter.	Yes	Yes

c	Share product to Google+.	Yes	Yes
d	Share product to Pinterest.	Yes	Yes
12	Subscribe		
a	Subscribe seller.	Yes	Yes
13	Help		
a	Select contact us.	No	No
14	Chat		
a	Chat between seller and buyer.	Yes	Yes
15	Order Tracking		
a	Seller enters the sales receipt number.	Yes	Yes
16	Application Download		
a	Download application for smartphone.	Yes	Yes
17	Seller		
a	Upload photo to sale by seller.	Yes	Yes
b	Import photo from Instagram.	Yes	Yes
c	Import photo from Facebook.	Yes	Yes
d	Seller account setting profile.	Yes	Yes
e	Top up electronic balance.	Yes	Yes
f	Cashed seller electronic balance.	Yes	Yes
g	Download electronic balance mutation.	Yes	Yes
18	Logout		
a	Logout user account.	Yes	Yes

According to the result of Functional Correctness and Functional Appropriateness sub characteristic testing on Bukalapak web application, percentage of Functional Correctness and Functional Appropriateness will be determined as follow by the total number of function is 50.

- Functional Correctness Sub Characteristic

$$Yes = \frac{46}{50} x 100\% = 92\%$$
$$No = \frac{4}{50} x 100\% = 8\%$$

- Functional Appropriateness Sub Characteristic

$$Yes = \frac{46}{50} x 100\% = 92\%$$
$$No = \frac{4}{50} x 100\% = 8\%$$

- Total Functional Correctness and Functional Appropriateness Sub Characteristic

$$FcrtFapp = \frac{Fcrt+Fapp}{TotalSubCharacteristic} = \frac{92\%+92\%}{2} = 92\%$$

Based on the calculation above, the result will be compared with Table 3.23. Indicator of Functional Correctness and Functional Appropriateness Sub Characteristic. The result is 92.16% which on level 5 with range 81%-100%. This shows that Bukalapak web applicaton has very good quality in Functional Correctness and Functional Appropriateness.

Based on sub characteristic testing result above, Table 4.20. Below is Functional Suitability characteristic testing result on Bukalapak web application.

Table 4.20: Bukalapak Website Testing Result on Functional Suitability Characteristic

No	Sub Characteristic	Actual Result	Level	Predicate
1	Functional Completeness	82.5%	5	Very Good
2	Functional Correctness	92%	5	Very Good
3	Functional Appropriateness	92%	5	Very Good

4.4.1.2 Testing of Performance Efficiency Characteristic

Testing of Performance Efficiency Characteristic is obtained in three sub characteristics, Time Behavior, Resource Utilization and Capacity. Here is the testing result of each sub characteristics in Performance Efficiency characteristic.Time Behavior Sub Characteristic

Testing of Time Behavior sub characteristic is obtained by calculate the average of response tim of each function application when application running. Testing will be done in three times using First Media Wi-Fi internet connection with average speed connection is 12.46 Mbps. Speed internet access is measured through http://www.speedtest.net/id/. Table 4.21. Below is testing result of Time Behavior sub characteristic on Bukalapak web application.

Table 4.21: Testing Result of Functional Completeness Sub Characteristic on Bukalapak Web Application

No	Test Case	Response Time (second)			Average Time
		Testing of-:			
		1st	2nd	3rd	(second)
1	Input registration data correctly in accorandce with registration terms.	3.12	3.09	3.46	3.22
2	Input registration data incorrectly in accorandce with registration terms.	2.98	3.47	3.15	3.20
3	Input registration data that have already been registered.	2.42	2.72	2.94	2.69
4	Input login data correctly.	3.48	3.92	3.77	3.72
5	Input login data incorrectly.	3.76	3.33	3.81	3.63
6	Login with correct Facebook account.	3.03	3.86	3.77	3.55
7	Login with incorrect Facebook account.	3.21	4.01	4.09	3.77
8	Login with correct Google+ account.	3.13	3.77	4.53	3.81
9	Login with incorrect Google+ account.	4.13	4.22	3.41	3.92
10	Login with correct Yahoo account.	-	-	-	-
11	Login with incorrect Yahoo account.	-	-	-	-
12	Forgot password when login.	7.42	7.31	6.59	7.11
13	Select one product category, example: Electronic category	5.22	5.19	6.40	5.60
14	Filter product by shipment. Example: TIKI	3.52	3.90	4.35	3.92
15	Filter combination using available filter that are price range, shipment and location.	4.31	4.11	4.59	4.34
16	Search “iPhone SE”.	2.31	2.11	2.78	2.40
17	Order product by entering stock quantity exceeds to stock provided by seller.	1.01	1.23	1.12	1.12
18	Order product by entering stock quantity according to stock provided by seller.	4.31	4.55	5.78	4.88
19	Sort product with lowest price.	1.09	1.11	1.02	1.07
20	Sort product with highest price.	1.06	1.38	1.20	1.21
21	Sort product with relevance.	1.32	1.46	2.09	1.62
22	Sort product with the newest.	2.31	2.00	1.89	2.07
23	Press “Buy” button to buy product.	3.13	3.57	4.93	3.88
24	Delete order in shopping cart.	2.31	2.55	2.91	2.59
25	Change quantity product from shopping cart.	2.12	1.86	2.93	2.30
26	Rating and comment on products previously purchased by users.	3.44	2.89	3.76	3.36
27	Rating and comment on a product that has never been	2.43	2.51	2.68	2.54

	purchased before by the user.				
28	Using valid voucher code for payment.ount.	4.32	6.42	5.14	5.29
29	Using invalid voucher code for payment.	5.21	4.88	6.32	5.47
30	Transfer payment method and enter correct payment code in accordance with notification.	8.65	9.43	9.76	9.28
31	Transfer payment method and enter incorrect payment code in accordance with notification.	4.56	5.12	5.68	5.12
32	Transaction done.	4.22	4.65	4.86	4.58
33	Select product to wishlist.	3.14	3.56	3.66	3.45
34	Share product to Facebook.	5.67	6.98	5.45	6.03
35	Share product to Twitter.	5.41	5.76	5.52	5.56
36	Share product to Google+.	4.31	6.32	5.55	5.39
37	Share product to Pinterest.	5.29	4.61	6.97	5.62
38	Subscribe seller.	2.13	2.01	2.87	2.34
39	Select contact us.	5.32	4.42	5.61	5.12
40	Chat between seller and buyer.	1.02	1.01	1.10	1.04
41	Seller enters the sales receipt number.	4.12	4.61	4.78	4.50
42	Download application for smartphone.	5.67	6.85	6.12	6.21
43	Upload photo to sale by seller.	3.24	3.56	3.91	3.57
44	Import photo from Instagram.	7.88	8.91	8.76	8.52
45	Import photo from Facebook.	10.52	9.45	10.63	10.20
46	Seller account setting profile.	3.42	4.21	4.77	4.13
47	Top up electronic balance.	7.32	7.65	7.44	7.47
48	Cashed seller electronic balance.	9.12	9.36	9.44	9.31
49	Download electronic balance mutation.	3.21	3.11	3.64	3.32
50	Logout user account.	6.14	7.09	6.53	6.59
Average		3.93	4.20	4.45	4.19

Testing result of Time Behavior sub characteristic has 4.19 seconds of average response time. This result is compared with Table 3.24. Indicator of Time Behavior Sub Characteristic which measure user satisfaction [10]. Once compared, the result is at level 4 which predicate is “Satisfied” with range of 3-9 seconds. This shows that Bukalapak web application has good quality in Time Behavior sub characteristic.

1. Resource Utilization Sub Characteristic

   Testing of Resource Utilization sub characteristic is obtained by observe

the processing of resources when application is running. The resource is the use of memory when application is accessed and surfing the website.

Table 4.22: Bukalapak Website Testing Result on Resource Utilization Sub Characteristic

Testing of-	With Cache (MB)	Without Cache (MB)
1st	112,774	81,780
2nd	132,801	98,564
3rd	126,115	99,592
Average	123,897	93,312

Based on Table 4.22. Above, the result will be compared with Table 3.26. Indicator of Resource Utilization sub characteristic. The result is at level 5 with "Very Good" predicate that shows Bukalapak web application in the use of memory is very good.

2. Capacity Sub Characteristic

   Testing of Capacity sub characteristic is obtained by testing the limit maximum of Bukalapak web application when using. Table 4.23. Below is the testing result of Capacity sub characteristic on Bukalapak web application.

Table 4.23: Bukalapak Website Testing Result on Capacity Sub Characteristic

No	Test Case	Actual Case	Actual Result
1	Input product into wishlist more than 100 products.	Input 150 different products into wishlist.	Success.
2	Input more than 100 products into shopping cart.	Input 150 different products into shopping cart.	Success.
3	Add more than 100 favorite stores to favorite stores menu.	Makes 150 favorite stores.	Success.

Based on Table 4.23. Above, the result will be compared with Table 3.27. Indicator of Capacity sub characteristic. The result is Bukalapak web application is at level 5 that "All test cases match the expected result" to show that the application has high capacity.

Table 4.24. Below is the summary of Bukalapak testing result on Performance Effieciency characteristic.

Table 4.24: Bukalapak Website Testing Result on Functional Suitability Characteristic

No	Sub Characteristic	Actual Result	Level	Predicate
1	Time Behavior	4.19 second	4	Satisfied
2	Resource Utilization	123,897 With Cache	5	Very Good
		93,312 Without Cache		
3	Capacity	All test cases match the expected result.	5	Very High Capacity

4.4.1.3 Testing of Compatibility Characteristic

Testing of Compatibility characteristic is done by testing its two sub characteristics, Co-Existence and Interoperability. Here are the testing result of each sub characteristic in Compatibility characteristic.

1. Co-Existence Sub Characteristic

   Testing of Co-Existence sub characteristic is done by accessing Bukalapak web application on several browsers using desktop, netbook and notebook through http://www.bukalapak.com (not redirecting to m.bukalapak.com). Table 4.25. Below is the testing result of Co-Existence sub characteristic on Bukalapak web application.

   Table 4.25: Testing Result of Functional Completeness Sub Characteristic on Bukalapak Web Application

No	Test Case	Device Specification	Actual Result
1	Bukalapak sites are accessed using Google Chrome browser.	Desktop	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
2	Bukalapak sites are accessed using Google Chrome browser.	Netbook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
3	Bukalapak sites are accessed using Google Chrome browser.	Notebook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
4	Bukalapak sites are accessed using Internet Explorer browser.	Desktop	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
5	Bukalapak sites are accessed using Internet Explorer browser.	Netbook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.

6	Bukalapak sites are accessed using Internet Explorer browser.	Notebook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
7	Bukalapak sites are accessed using Safari browser.	Desktop	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
8	Bukalapak sites are accessed using Safari browser.	Netbook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
9	Bukalapak sites are accessed using Safari browser.	Notebook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
10	Bukalapak sites are accessed using Mozilla Firefox browser.	Desktop	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
11	Bukalapak sites are accessed using Mozilla Firefox browser.	Netbook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
12	Bukalapak sites are accessed using Mozilla Firefox browser.	Notebook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
13	Bukalapak sites are accessed using Opera browser.	Desktop	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
14	Bukalapak sites are accessed using Opera browser.	Netbook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.
15	Bukalapak sites are accessed using Opera browser.	Notebook	Bukalapak sites running well (no features could not run) and not redirected to m.bukalapak.com.

Based on Table 4.25. Above, the results will be compared with Table 3.28. Indicator of Co-Existence sub characteristic. The result is “All test cases match the expected result” at level 5. This shows Bukalapak web application is very good on Co-Existence.

2. Interoperability Sub Characteristic

Testing of Interoperability sub characteristic is done by observing the Bukalapak web application to sharing information with other system. Table 4.26. Below is the testing result of Interoperability sub characteristic on Bukalapak web application.

Table 4.26: Bukalapak Website Testing Result on Interoperability Sub Characteristic

No	Test Case	Actual Result
1	Sign up with Google account.	Registered data is according to the connected Google account.
2	Sign up with Facebook account.	Registered data is according to the connected Facebook account.
3	Sign up with Yahoo account.	Bukalapak does not provide Sign up with Yahoo account.
4	Login with Google account.	Login data is according to the connected Google account.
5	Login with Facebook account.	Login data is according to the connected Facebook account.
6	Login with Yahoo account.	Bukalapak does not provide login with Yahoo account.
7	Login with Email account.	Login data is according to the connected email account.
8	Payment with virtual account number.	Payment transaction success and automatically confirmed.
9	Share product to Facebook.	Product shared by users shows on Facebook's user home page.
10	Share product to Twitter.	Product shared by users shows on Twitter's user home page.
11	Share product to Google+.	Product shared by users shows on Google+'s user home page.
12	Share product to Pinterest.	Product shared by users shows on Pinterest's user home page.
13	Share product to Instagram.	Bukalapak does not provide share feature to Instagram.
14	Share product to Blogger.	Bukalapak does not provide share feature to Blogger.
15	Order Tracking.	Bukalapak provides delivery status information of products purchased by the user.

Based on Table 4.26. Above, the testing result will be compared with Table 3.29. Indicator of Interoperability sub characteristic. The testing result is Bukalapak web application at level 3 that "There are four test cases do not match with the expected result" to shows that Interoperability is on moderate.

Table 4.27. Below is the summary of Compatibility sub characteristic testing result on Bukalapak web application.

Table 4.27: Bukalapak Website Testing Result on Compatibility Characteristic

No	Sub Characteristic	Actual Result	Level	Predicate
1	Co-Existence	All test cases match the expected result.	5	Very Good
2	Interoperability	There are four test cases do not match the expected result.	3	Moderate

4.4.1.4 Testing of Usability Characteristic

Testing of Usability characteristic on Bukalapak web application consists of six sub characteristics. They are Appropriateness Recognisability, Learn-

ability, Operability, User Error Protection, User Interface Aesthetics, and Accessibility sub characteristic. Testing of Usability characteristic using questionnaire adopted by Lund with 400 respondents. Respondents are users of both application, Bukalapak and Tokopedia web application. Before the questionnaire distributed to all respondents, first tested the validity and reliability with sampling 30 respondents from both application users who have S1 and S2 education in IT with age range 20-35 years. Here are the testing result of vaidity and reliability on Usability characteristic.

1. Result of Validity Testing

   Validity testing on Usability characteristic is obtained using SPSS by looking at Pearson Correlation value from each variable. The value of R Table used is 5% significance level is 0.3610. Table 4.28. Below is the validity testing result on Usability characteristic.

Table 4.28: Result of Validity Testing on Usability Characteristic

Instrument	Pearson Correlation rhitung (rxy)	R Table (rtable)	Significance Level	Validity
AR	1,000	0.3610	0.05	Valid
LN1	0.945	0.3610	0.05	Valid
LN2	0,946	0.3610	0.05	Valid
OP1	0,849	0.3610	0.05	Valid
OP2	0,842	0.3610	0.05	Valid
UE1	0,909	0.3610	0.05	Valid
UE2	0,840	0.3610	0.05	Valid
UI1	0,885	0.3610	0.05	Valid
UI2	0,874	0.3610	0.05	Valid
AC1	0,905	0.3610	0.05	Valid
AC2	0,905	0.3610	0.05	Valid

AR = Appropriateness Recognisability

LN = Learnability

OP = Operability

UE = User Error Protection

UI = User Interface Aesthetics

AC = Accessibility

Based on the results of the validity testing Usability characteristic in the Table 4.28. Above, there are 11 testing instruments that each instrument represents from Usability sub characteristic indicates that all instruments are valid. It is valid because the value of Pearson Correlation (rhitung (rxy)) is greater than the value of R Table, so the data

produced accurately and reliably with the minimum standard (rhitung (rxy)) is 0.3610 and 95% confidence level.

2. Result of Reliability Testing

   After testing the validity, then is to test the reliability of each variable. Reliability testing is determined to measure the accuracy and consistency of value on each instrument respond by respondents. Accuracy and consistency value is obtained by Cronbach-Alpha value converted into the reliability coefficient category. Table 4.29. Below is testing result of reliability testing on Usability characteristic.

Table 4.29: Result of Reliability Testing on Usability Characteristic

Instrument	Cronbach-Alpha	Reliability
AR	0,886	Reliable
LN1	0,883	Reliable
LN2	0,874	Reliable
OP1	0,877	Reliable
OP2	0,897	Reliable
UE1	0,882	Reliable
UE2	0,888	Reliable
UI1	0,883	Reliable
UI2	0,883	Reliable
AC1	0,888	Reliable
AC2	0,883	Reliable

Table 4.29. Above shows that 11 instruments on Usability characteristic with average Cronbach-Alpha value above 0.8. According to Reliability Index Criteria [23], all instruments that tested on Usability characteristic generates data with very high reliability or consistency. It shows that all tested instruments generate reliable data.

After obtaining the results of validity and reliability testing from each instrument on Usability characteristic, then is to distributed questionnaire to 400 respondents that have been sampling in this research with respondent's criteria as described in previous discussion. Table 4.30. Below is the questionnaire response from respondents in Usability characteristic on Bukalapak web application.

Table 4.30: Response from Respondents Usability Questionnaire Bukalapak Website

No	Sub Characteristic	Frequency Response Respondents					Mode
		STS	TS	N	S	SS	
1	AR	16	23	97	228	36	S
2	LN1	13	17	85	218	67	S
3	LN2	15	15	91	223	56	S
4	OP1	18	19	79	233	51	S
5	OP2	8	34	100	208	50	S
6	UE1	14	28	180	143	35	N
7	UE2	12	35	208	126	19	N
8	UI1	15	43	100	212	30	S
9	UI2	12	25	115	188	60	S
10	AC1	21	18	148	176	37	S
11	AC2	20	21	86	197	76	S

After having the result as Table 4.30. Above, the calculation scale is calculated by formula that previously explained in order to obtain the feasibility value from Usability characteristic. The calculation is explained on following Table 4.31. Below.

Table 4.31: Usability Testing Result of Bukalapak Website

Interpretation	Total (I)	Likert Scale (S)	I x S
STS	164	1	164
TS	278	2	556
N	1289	3	3867
S	2152	4	8608
SS	517	5	2585
Total $\sum$ I x S			15780
Maximum Value MaxU			22000

After having feasibility value that shows on Table 4.31. Above, then is to do the calculation to get the result testing of Usability characteristic. The calculation is explained on formula below.

$$\frac{\sum IxS}{MaxU} x100\% = \frac{15780}{22000} x\ 100\% = 71.72\%$$

Based on calculation above, result of Ussability Characteristic testing is 71.72%. The percentage is compared with Table 3.30. Score Interpretation of Usability Characteristic.The result is at level 4 with range 61% - 80%. Whereas if viewed from Table of Response from Respondents, mode from the responses is “S”. It shows that the ability of Bukalapak web application to be used by users is in criteria of Usabilty is Good.

4.4.1.5 Testing of Reliability Characteristic

Testing of Reliability Characteristic is performed by its four sub characteristics, Maturity, Availability, Fault Tolerance and Recoverability. Here is the detailed of testing result of each sub characteristic in Reliability characteristic on Bukalapak web application.

1. Maturity Sub Characteristic

   Testing of Maturity sub characteristic is obtained by observing which a system, product or component meets needs for reliability under normal operation on Bukalapak web application. Table 4.32. Below is testing result of Maturity sub characteristic on Bukalapak web application.

Table 4.32: Result of Maturity Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result
1	Login with account that does not match with account that has been registered.	Unable to login. User is asked to check the username and password entered.
2	Added 100 products for sale.	Products successfully added.
3	Push promoted for 100 products sales.	Push promoted success.
4	Added 100 products to shopping cart.	Products successfully added to shopping cart.

2. Availability Sub Characteristic

   Testing of Availability sub characteristics aims to see application performance to fulfill needs of user when application used. Table 4.33. Below is test case of Availability sub characteristic.

Table 4.33: Result of Availability Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result
1	Access Bukalapak in Days of National Online Shopping	Bukalapak running normally.
2	Access Bukalapak in Ramadhan Sale Day	Bukalapak running normally.

3. Fault Tolerance Sub Characteristic

   Testing of Fault Tolerance sub characteristic is obtained by ensuring which a system, product or component operates as intended despite the presence of hardware or software faults on Bukalapak web application. Table 4.34. Below is testing result of Fault Tolerance sub characteristic on Bukalapak web application.

Table 4.34: Result of Fault Tolerance Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result
1	Create an account with inappropriate email address 10 times.	Account was not successfully created.
2	Sign up account with incorrect password terms 10 times.	Account was not successfully created.
3	Login with incorrect registered account 10 times.	Unable to login. User is requested to double check the username and password entered whether it is in accordance with the previously registered account.
4	Payment using incorrect virtual account code three times.	Unable to continue the next process.

Based on Table 4.34. Above, the results will be compared with Table 3.33. Indicator of Fault Tolerance sub characteristic. The result is "All test cases match with the expected result" at level 5. That shows Bukalapak web application is very good on Fault Tolerance aspect.

4. Recoverability Sub Characteristic

   Testing of Recoverability is obtained by observing which, in the event of an interruption or a failure, a product directly affected and re-establish the desired state of the system on Bukalapak web application. Table 4.35. Below is the testing result of Recovery sub characteristic on Bukalapak web application.

Table 4.35: Result of Recoverability Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result
1	Disconnect internet connection when ordering products.	Yes, the ordering process can not be done and Bukalapak provides information to retry the transaction.
2	Enable airplane mode when ordering products.	Yes, the ordering process can not be done and Bukalapak provides information to retry the transaction.
3	Device shut down when ordering product.	Yes, the ordering process can be resumed when the device is on.

Based on Table 4.35. Above, the results will be compared with Table 3.34. Indicator of Recoverability sub characteristic. The result is "All test cases match with the expected result" at level 5. That shows Bukalapak web application is very good on Recoverability aspect.

Table 4.36. Below is the summary of Reliability characteristic testing result on Bukalapak web application.

Table 4.36: Result of Reliability Characteristic Testing on Bukalapak Web Application

No	Sub Characteristic	Actual Result	Level	Predicate
1	Maturity	All test cases match the expected result	5	Very Good
2	Availability	All test cases match the expected result	5	Very Good
3	Fault Tolerance	All test cases match the expected result.	5	Very Good
4	Recoverability	All test cases match the expected result.	5	Very Good

4.4.1.6 Testing of Security Characteristic

Testing of Security characteristic on Bukalapak web application is performed by its five sub characteristics, Confidentiality, Integrity, Non-Repudiation, Accountability and Authenticity. Here is the detailed of testing result of each sub characteristic in Security characteristic on Bukalapak web application.

1. Confidentiality Sub Characteristic

   Testing of Confidentiality aims to ensure that data are accessible only to those authorized to have access on Bukalapak web application. Table 4.37. Below is the testing result of Confidentiality sub caharacteristic on Bukalapak web application.

Table 4.37: Result of Confidentiality Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result	Score Qn
1	Fill registration data with emptying one field.	Display an error message to fill empty field.	1
2	Fill registration data with less than 4 characters.	Display an error message password is too short.	1
3	Fill confirmation password different from the password data to be used.	Display an error message password does not match the confirmation password field.	1
4	Fill registration data with incomplete email address.	Display an error message email does not match.	1
5	Fill registration data using the same email address.	Display an error message email already exists.	1

   Based on Table 4.37. Above, those scores on testing of Confidentiality characteristic will be calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{confidentiality} = \frac{5}{5} x\ 100\% = 100\%$$

The result obtained of the above formula is 100% at level 5. It shows that the ability Bukalapak web application is accessible only to those authorized to have an access is very high.

2. Integrity Sub Characteristic

Testing of Integrity sub characteristic aims to ensure Bukalapak web application is able to prevent unauthorized access rights into the system. Table 4.38. Below is the result of Integrity sub characteristic testing on Bukalapak web application.

Table 4.38: Result of Integrity Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result	Score Qn
1	Fill login data: a. Incorrect username. b. Correct password.	Displays an error message to check the username and password entered.	1
2	Fill login data: a. Correct username. b. Inorrect password.	Displays an error message to check the username and password entered.	1
3	Reset Password	Sends a password reset message to email.	1
4	Login using Facebook account.	Displays a verification message to sign in with a connected Facebook account.	1
5	Login using Google+ account.	Displays a verification message to sign in with a connected Google+ account.	1
6	Login using Yahoo account.	Bukalapak does not provide login with Yahoo account.	0

Based on Table 4.38. Above, those scores on testing of Confidentiality characteristic will be calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{integrity} = \frac{5}{6} x\ 100\% = 83.33\%$$

The result obtained of the above formula is 83.33% at level 5. It shows that the ability of Bukalapak web application to prevent unauthorized access rights into the system is very high.

3. Non-Repudiation Sub Characteristic

Testing of Non-repudiation sub characteristic aims to ensure Bukalapak web application which actions or events cannot be repudiated later.

Table 4.39. Below is the result of Non-repudiation sub characteristic testing on Bukalapak web application.

Table 4.39: Result of Non-Repudiation Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result	Score Qn
1	Register through application site	Bukalapak provides proof of registration by email.	1
2	Order product	Bukalapak provides proof of order by email or SMS.	1
3	Payment confirmation	Bukalapak provides proof of payment confirmation by email or SMS.	1
4	Cancellation order.	Bukalapak does not provide proof of cancellation order by email or SMS.	0
5	Product received.	Bukalapak provides proof of product received by email or SMS.	1

Based on Table 4.39. Above, those scores on testing of Non-repudiation characteristic will be calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{non-repudiation} = \frac{4}{5} x\ 100\% = 80\%$$

The result obtained of the above formula is 80% at level 4. It shows that the ability of Bukalapak web application to provide proof of every access and transaction is High.

4. Accountability Sub Characteristic

Testing of Accountability sub characteristic aims to ensure Bukalapak web application is able to trace all activities of user. Table 4.40. below is the result of Accountability sub characteristic testing on Bukalapak web application.

Table 4.40: Result of Accountability Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result	Score Qn
1	View order transaction.	Bukalapak provides information of ordered product and current transaction.	1
2	View purchase transaction.	Bukalapak provides information of purchased product and current transaction.	1
3	View payment transaction.	Bukalapak provides information of current payment transaction status.	1
4	View transaction of received product.	Bukalapak provides history of receipt purchased products.	1
5	View wishlist history.	Bukalapak provides history of wishlist's user.	1
6	Search history.	Bukalapak provides history of searched products.	1
7	Product discussion history.	Bukalapak provides history of product discussion by user.	1
8	Chat history.	Bukalapak provides the conversation history between seller and buyer through chat application.	1

Based on Table 4.40. Above, testing result of Accountability sub characteristic is calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{accountability} = \frac{8}{8} x\ 100\% = 100\%$$

The result obtained from Accountability sub characteristic is 100% at level 5. It shows that the ability of Bukalapak web application in tracking activities by users is very high.

5. Authenticity Sub Characteristic

   Testing of Authenticity sub characteristic aims to ensure which the identity of a subject or resource can be proved to be the one claimed on Bukalapak web application. Table 4.41. below is the testing result of Authenticity sub characteristic on Bukalapak web application based on test cases that have been tested.

Table 4.41: Result of Authenticity Sub Characteristic Testing on Bukalapak Web Application

No	Test Case	Actual Result	Score Qn
1	Registration.	Bukalapak sends data verification through email.	1
2	Change password.	Change password success.	1
3	Update account.	Account updated.	1
4	Login in several browsers using different devices without logout first.	Bukalapak provides information through email that account that entered is logged in on another device.	1

Based on Table 4.41. Above, testing result of Authenticity sub characteristic is calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{authenticity} = \frac{4}{4} x\ 100\% = 100\%$$

Testing result of Authenticity sub characteristic is 100% and at level 5. That shows Bukalapak web application is very high to identity of a subject or resource which can be proved to be the one claimed.

Table 4.42. Below is the summary of Security characteristic testing result on Bukalapak web application.

Table 4.42: Result of Security Characteristic Testing on Bukalapak Web Application

No	Sub Characteristic	Result	Level	Predicate
1	Confidentiality	100%	5	The prototype ensures that data are accessible only to those authorized to have access is Very High.
2	Integrity	100%	5	Ability of application to prevent unauthorized access is Very High.
3	Non-Repudiation	80%	4	Ability of the application to provide evidence against the action/ transaction that has been done is High.
4	Accountability	100%	5	Ability of application to track activities of user is Very High.
5	Authenticity	100%	5	Ability of application to provide confirmation the authenticity of user data is Very High.

4.4.2 Testing of Characteristic in Quality in Use Dimension

Testing of characteristic in Quality in Use dimension is done with similar methode with Usability characteristic in Product Quality, is based on user perspective through questionnaire. The questionnaire is adopted by Lund A.R. using 400 respondents. Respondents were the same as respondents who

responded to Usability characteristic. Before the questionnaire was disseminated, it was first tested the validity and reliability to 30 respondents with IT background and as the user of Bukalapak and Tokopedia web application. Testing of characteristic in Quality in Use dimension is performed by its nine sub characteristics, Effectiveness, Efficiency, Usefulness, Trust, Pleasure, Comfort, Environment Risk Mitigation, Health & Safety Risk Mitigation and Content Completeness. Here are the result of validity and reliability testing of Quality in Use dimension.

4.4.2.1 Result of Validity Testing

The validity result can be seen by using the Pearson Correlation value between each variable item with the variable it self. The minimum number of Pearson correlation value to be valid for the research is 0.3610 [23] It refers to Table R by using the value of signicance level at 5% with 30 number of sample [23]. Table 4.43. Below is the result of validity testing of Quality in Use Dimension.

Table 4.43: Result of Validity Testing of Characteristic in Quality in Use Dimension

Instrument	Pearson Correlation rhitung (rxy)	R Table (rtable)	Significance Level	Validity
EF1	0,856	0.3610	0.05	Valid
EF2	0,909	0.3610	0.05	Valid
EC1	0,871	0.3610	0.05	Valid
EC2	0,887	0.3610	0.05	Valid
US1	0,835	0.3610	0.05	Valid
US2	0,848	0.3610	0.05	Valid
TR1	0,848	0.3610	0.05	Valid
TR2	0,862	0.3610	0.05	Valid
PL1	0,926	0.3610	0.05	Valid
PL2	0,895	0.3610	0.05	Valid
CM1	0,877	0.3610	0.05	Valid
CM2	0,907	0.3610	0.05	Valid
ER	1,000	0.3610	0.05	Valid
HS	1,000	0.3610	0.05	Valid
EN	1,000	0.3610	0.05	Valid
CC	1,000	0.3610	0.05	Valid
FL	1,000	0.3610	0.05	Valid

Based on Table 4.43. Above is obtained that 17 tested instruments are valid. This is indicated by the value of Pearson Correlation or rhitung (rxy)

is greater than value of R Table or rtable so that the measured instruments on Quality in Use dimension have accurate and reliable data with minimum standard value of rhitung (rxy) is 0.3610 and 95% level of trust.

4.4.2.2 Result of Reliability Testing

After having the result of validity testing, then is tested the reliability of each variable. Reliability testing aims to measure the precision and consistency of score on each instrument that responded by respondents. The precision and consistency of score is obtained by Cronbach-Alpha value that converted into reliability coefficient category. Table 4.44. Below is reliability testing result of Quality in Use dimension.

Table 4.44: Result of Reliability Testing of Characteristic in Quality in Use Dimension

Instrument	Cronbach-Alpha	Reliability
EF1	0.919	Reliable
EF2	0.919	Reliable
EC1	0.920	Reliable
EC2	0.917	Reliable
US1	0.922	Reliable
US2	0.918	Reliable
TR1	0.917	Reliable
TR2	0.918	Reliable
PL1	0.917	Reliable
PL2	0.917	Reliable
CM1	0.921	Reliable
CM2	0.918	Reliable
ER	0.923	Reliable
HS	0.926	Reliable
EN	0.923	Reliable
CC	0.917	Reliable
FL	0.919	Reliable

Table 4.44. Above shows that 17 instruments of Quality in Use dimension are having average of Cronbach-Alpha value above 0.9. Based on Reliability Index Criteria, Cronbach-Alpha value of all tested instruments on Quality in Use dimension show very high reliability or consistency [23]. It shows that all tested instuments have reliable data.

4.4.2.3 Result of Testing Characteristic in Quality in Use Dimension

After testing the validity and reliability to 30 respondents, it shows the results on all questionnaire items are valid and reliable, the distribute the questionnaire to 400 respondents who are sampled with criteria that previously described. Table 4.45. Below is the result of response from respondents Quality in Use on Bukalapak web application.

Table 4.45: Response from Respondents Quality in Use Questionnaire Bukalapak Website

No	Sub Characteristic	Frequency Response Respondents					Mode
		STS	TS	N	S	SS	
1	EF1	13	18	85	236	48	S
2	EF2	15	21	99	201	64	S
3	EC1	12	46	170	142	30	N
4	EC2	12	23	103	180	82	S
5	US1	12	29	172	154	33	N
6	US2	14	16	149	186	35	S
7	TR1	18	33	125	193	31	S
8	TR2	15	17	109	231	28	S
9	PL1	15	33	155	173	24	S
10	PL2	11	24	135	207	23	S
11	CM1	13	24	165	175	23	S
12	CM2	15	23	105	229	28	S
13	ER	21	78	128	133	40	S
14	HS	16	59	134	153	38	S
15	EN	16	36	187	143	18	N
16	CC	16	27	198	143	16	N
17	FL	21	18	76	237	48	S

After having the results on Table 4.45. Above, the calculation scale is calculated using formula that previously described to have feasibility value from Quality in Use dimension. Table 4.46. Below is the calculation of Quality in Use testing result on Bukalapak web application.

Table 4.46: Quality in Use Testing Result of Bukalapak Website

Interpretation	Total (I)	Likert Scale (S)	I x S
STS	255	1	255
TS	525	2	1050
N	2295	3	6885
S	3115	4	12464
SS	609	5	3045
Total $\sum$ I x S			23699
Maximum Value MaxU			34000

After having the feasibility value on Table 4.46. Above, then do the calculation to have the testing results of Usability characteristic. The calculation is described as formula below.

$$\frac{\sum IxS}{MaxU} x\ 100\% = \frac{23699}{34000} 100\% = 69.70\%$$

Based on calculation above, the testing result of Quality in Use dimension is 69.70%. The percentage is compared with Table 3.30. Score Interpretation. The result is at level 4 with range range 61% - 80%. Whereas from mode of table response from respondents is “S”. It shows that the ability of Bukalapak web application to be used by users in the criteria of effectivity, efficiency, satisfaction, freedom from risk and context completeness is Good.

4.4.3 Testing Result of Bukalapak Web Application Quality (www.bukalapak.com)

The calculation of the value of each Characteristic and sub Characteristic ISO 25010 on Product Quality and Quality in Use dimension has been successfully done on the Bukalapak web application. After sub characteristic value of obesrvation result or questionnaire is indicated by level on indicator, the value of that level is calculated by sub Characteristic weight to see whether the result of calculation is equal to weight or lower than weight. The result of Product Quality dimension is obtained as Table 4.47. Below.

Table 4.47: Testing Result of Product Quality Dimension on Bukalapak Web Application

Characteristic	Characteristic Weighted Value	Sub Characteristic	Sub Characteristic Weighted Value (Wn)	Level (Ln)	Sub Characteristic Value (ValueSCn)	Characteristic Value (ValueCn)

Functional Suitability	21.4%	Functional Completeness	1.18%	5	1.18%	21.4%
		Functional Correctness	6.21%	5	6.21%	
		Functional Appropriaten	14.02%	5	14.02%	
Performance Efficiency	25.3%	Time Behavior	16.12%	4	12.90%	22.09%
		Resource Utilization	6.53%	5	6.53%	
		Capacity	2.66%	5	2.66%	
Compatibility	9.7%	Co-Existence	1.62%	5	1.62%	6.47%
		Interoperability	8.08%	3	4.85%	
Usability	15.4%	Appropriateness Recognizability	0.86%	4	0.69%	12.32%
		Learnabiilty	3.93%	4	3.14%	
		Operability	2.51%	4	2.01%	
		User Error Protection	2.09%	4	1.67%	
		User Interface Aesthetics	2.09%	4	1.67%	
		Accessibility	3.93%	4	3.14%	
Reliability	12.8%	Maturity	1.24%	5	1.24%	12.8%
		Availability	2.68%	5	2.68%	
		Fault Tolerance	0.65%	5	0.65%	
		Recoverability	8.23%	5	8.23%	
Security	15.4%	Confidentiality	4.91%	5	4.91%	15.1%
		Integrity	4.99%	5	4.99%	
		Non-Repudiation	1.46%	4	1.17%	
		Accountability	1.29%	5	1.29%	
		Authenticity	2.74%	5	2.74%	
Total Weight	100%	Product Quality Result				90.18%

Table 4.47. Above shows that the quality of Bukalapak web application on Product Quality dimension is 90.18%. It shows that the quality of Bukalapak web application 9.82% below the maximum weight of E-Commerce applica-

tion quality. Overall quality of Bukalapak web application on Product Quality dimension is good.

Furthermore, in the testing of Quality in Use dimension is obtained by questionnaire. This is done because the Quality in Use dimension is the quality of application that measure by user's perspective. Table 4.48. Below is the testing result of Quality in Use dimension on Bukalapak web application.

Table 4.48: Testing Result of Product Quality Dimension on Bukalapak Web Application

Characteristic	Characteristic Weighted Value	Sub Characteristic	Sub Characteristic Weighted Value (Wn)	Level (Ln)	Sub Characteristic Value (ValueSCn)	Characteristic Value (ValueCn)
Effectiveness	18.6%	Effectiveness	18.6%	4	14.88%	14.88%
Efficiency	16.0%	Efficiency	16.0%	4	12.80%	12.80%
Satisfaction	14.8%	Usefulness	4.01%	4	3.21%	11.86%
		Trust	8.05%	4	6.44%	
		Pleasure	0.95%	4	0.76%	
		Comfort	1.81%	4	1.45%	
Freedom from Risk	13.0%	Economic Risk Mitigation	8.28%	4	6.62%	10.4%
		Environmental Risk Mitigation	1.37%	4	1.10%	
		Health and Safety Risk Mitigation	2.09%	4	2.68%	
Context Coverage	37.6%	Context Completeness	32.9%	4	26.32%	30.08%
		Flexibility	4.7%	4	3.76%	
Total Weight	100%	Quality in Use Result				80.02%

Table 4.48. Above shows that the quality of Bukalapak web application on Quality in Use dimension is 80.02%. It shows that the quality of Bukalapak web application 19.98% below the maximum weight of E-Commerce application quality. Overall quality of Bukalapak web application on Quality in Use dimension is at level 4. It shows that the quality of Bukalapak web application on Quality in Use dimension is good from user's perspective.

Furthermore, the researcher will be explained the result of each sub characteristic using priority Table. This is to ensure that the criteria on Bukalapak web application meet the characteristic quality with weighting based on the priority ranking of Product Quality and Quality in Use dimension. Table 4.49. Below is priority ranking result of Product Quality dimension on Bukalapak web application.

Table 4.49: Priority Ranking Result of Product Quality Dimension on Bukalapak Web Application

No	Sub Charactertistic	Ranking	Relative Weight	Result
2.1.	Time Behavior	1	16.12%	12.90%
1.3.	Functional Appropriateness	2	14.02%	14.02%
5.4.	Recoverability	3	8.23%	8.23%
3.2.	Interoperability	4	8.08%	4.85%
2.2.	Resource Utilization	5	6.53%	6.53%
1.2.	Functional Correctness	6	6.21%	6.21%
3.2.	Confidentiality	7	4.91%	4.91%
3.1.	Integrity	8	4.99%	4.99%
4.2.	Learnabilty	9	3.93%	3.14%
4.6.	Accessibility	10	3.93%	3.14%
3.3.	Authenticity	11	2.74%	2.74%
5.2.	Avalability	12	2.68%	2.68%
2.3.	Capacity	13	2.66%	2.66%
4.3.	Operability	14	2.51%	2.01%
4.4.	User Error Protection	15	2.09%	1.67%
4.5.	User Interface Aesthetics	16	2.09%	1.67%
3.1.	Co-Existence	17	1.62%	1.62%
3.4.	Non-Repudiation	18	1.46%	1.17%
3.5.	Accountability	19	1.29%	1.29%
5.1.	Maturity	20	1.24%	1.24%
1.1.	Functional Completeness	21	1.18%	1.18%
4.1.	Appropriateness Recognizability	22	0.86%	0.69%
5.3.	Fault Tolerance	23	0.65%	0.65%
5.3.	Total Weight		100%	90.18%

Table 4.49 Above shows that Bukalapak web application has met the most important characteristic criteria tha must be required with the percentage of quality of each sub characteristic in accordance with the appropriate percentage. While the priority ranking of sub characteristic in Quality in Use dimension can be seen in Table 4.50. Below.

Table 4.50: Priority Ranking Result of Quality in Use Dimension on Bukalapak Web Application

No	Sub Charactertistic	Ranking	Relative Weight	Result
2.1.	Context Completeness	1	32.9%	26.32%
1.3.	Effectiveness	2	18.6%	14.88%
5.4.	Efficiency	3	16.0%	12.80%
3.2.	Trust	4	8.05%	6.44%
2.2.	Economic Risk Mitigation	5	8.28%	6.62%
1.2.	Flexibility	6	4.70%	3.76%
3.2.	Usefulness	7	4.01%	3.21%
3.1.	Health and Safety Risk Mitigation	8	3.35%	2.68%
4.2.	Comfort	9	1.81%	1.45%
4.6.	Environmental Risk Mitigation	10	1.37%	1.10%
3.3.	Pleasure	11	0.95%	0.76%
5.3.	Total Weight		100%	80.02%

Table 4.50. Above shows that Bukalapak web application is able to meet the most important criteria required by the percentage of quality of each sub characteristic generates a number that is not too far from the appropriate percentage.

4.5 Testing of Tokopedia Web Application (www.tokopedia.com)

Tokopedia web application which site is www.tokopedia.com is an application that provides buying and selling from consumer to consumer (C2C). Tokopedia web application will be tested for its quality through www.tokopedia.com that accessed on notebook AXIOO neon RNO 14 inch with processor Intel Core i7-3630QM (2.640 GHz), RAM 4 GB, Hardisk 500 GB and Operating System Windows 8.1. (Win 64) using standard of ISO 25010 Quality Model. Here are the test results of each dimension in ISO 25010 Quality Model.

4.5.1 Testing of Characteristic in Product Quality Dimension

Testing of Tokopedia web application through www.tokopedia.com begins with testing the Product Quality dimension. Based on adjustment characteristic and sub characteristic ISO 25010 Quality Model which have been

done before, characteristic on Product Quality dimension will be tested is Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability and Security characteristic.

4.5.1.1 Testing of Functional Suitability Characteristic

Testing of Functional Suitability characteristic on tokopedia web application through www.tokopedia.com consists of three sub characteristic assessments, that are Functional Completeness, Functional Correctness and Functional Appropriateness.

1. Functonal Completeness Sub Characteristic

   Testing of Functional Completeness sub characteristic on Tokopedia web application (www.tokopedia.com) is obtained using Black Box Testing by an employee as Quality Assurance (QA) in a technology company as a tester. This test is done by observing the completeness of function on Tokopedia website. Table 4.51. Below is Tokopedia web application testing result on Functional Completeness sub characteristic.

   Table 4.51: Testing Result of Functional Completeness Sub Characteristic on Bukalapak Web Application

No	Test Case	Actual Result
1	Application has registration function as new user.	Yes
2	Application has login function connected to Facebook.	Yes
3	Application has login function connected to Yahoo.	Yes
4	Application has login function connected to Google.	Yes
5	Application has product category.	Yes
6	Application has search function.	Yes
7	Application has wishlist feature.	Yes
8	Application has rating feature.	Yes
9	Application has filter function of certain categories.	Yes
10	Application has sort function of certain categories.	Yes
11	Application has rating feature to product.	Yes
12	Application has share feature to Line application.	Yes
13	Application has share feature to Facebook application.	Yes
14	Application has share feature to Twitter application.	Yes
15	Application has share feature to Google+ application.	Yes

16	Application has share feature to Pinterest application.	Yes
17	Application has product specification (product detail information).	Yes
18	Application has seller information.	Yes
19	Application has chat feature.	Yes
20	Application has a feature of providing a review of a product already purchased.	Yes
21	Application has product discussion through Q&A.	Yes
22	Application has Shopping Cart.	Yes
23	Application has electronic payment system.	Yes
24	Application has help menu.	Yes
25	Application has feature of adding product to sale.	Yes
26	Application has feedback feature.	Yes
27	Application has function to provide notification.	Yes
28	Application has feature to check transaction status.	Yes
29	Application has bargain feature.	Yes
30	Application has refund feature.	No
31	Application has pre-order feature.	Yes
32	Application has feature to favorite product.	Yes
33	Application has forgot password feature.	Yes
34	Application provide statistics of seller information.	Yes
35	Application has subscription feature.	Yes
36	Application has seller profile setting feature.	No
37	Application has feature to upload photos connected to Instagram for seller.	Yes
38	Application has feature to upload photos connected to Facebook for seller.	Yes
39	Application has premium account for seller.	No
40	Application has logout menu.	Yes

According to the results of Functional Completeness sub characteristic testing on Tokopedia web application, percentage of Functional Completeness sub characteristic can be determined as follow by the total number of completeness is 40 functions.

$$Yes = \frac{37}{40} x 100\% = 92.5\%$$

$$No = \frac{3}{40} x 100\% = 7.5\%$$

Based on calculation above, the result will be compared with Table 3.22. Indicator of Functional Completeness Sub Characteristic. The result is 92,5% which on level 5 with range 81%-100%. This shows that

Tokopedia web applicaton has very good quality in Functional Completeness aspect.

2. Functional Correctness and Functional Appropriateness Sub Characteristic

   Testing of Functional Correctness and Functional Appropriateness sub characteristic is obtained with same method on Functional Completeness testing, using Black Box Testing. Tester on this test is same with Functional Completeness testing, an employee as Quality Assurance (QA) in a technology company. Table 4.52. Below is Tokopedia web application testing result on Functional Correctness and Functional Appropriateness sub characteristic.

   Table 4.52: Testing Result of Functional Correctness and Functional Appropriateness Sub Characteristic on Tokopedia Web Application

No	Test Case	Actual Result	
		F. Correctness	F. Appropriateness
1	Registration		
a	Input registration data correctly in accordance with registration terms.	Yes	Yes
b	Input registration data incorrectly in accorandce with registration terms.	Yes	Yes
c	Input registration data that have already been registered.	Yes	Yes
2	Login		
a	Input login data correctly.	Yes	Yes
b	Input login data incorrectly.	Yes	Yes
c	Login with correct Facebook account.	Yes	Yes
d	Login with incorrect Facebook account.	Yes	Yes
e	Login with correct Google+ account.	Yes	Yes
f	Login with incorrect Google+ account.	Yes	Yes
g	Login with correct Yahoo account.	Yes	Yes
h	Login with incorrect Yahoo account.	Yes	Yes
3	Forgot Password		
a	Forgot password when login.	Yes	Yes
4	Select Product Category		

a	Select one product category. Example: Electronic category.	Yes	Yes
b	Filter product by shipment. Example: TIKI	Yes	Yes
c	Filter combination using available filter that are price range, shipment and location.	Yes	Yes
5	Search Product		
a	Search “iPhone SE”	Yes	Yes
6	Select Product		
a	Order product by entering stock quantity exceeds to stock provided by seller.	Yes	Yes
b	Order product by entering stock quantity according to stock provided by seller.	Yes	Yes
c	Sort product with lowest price.	Yes	Yes
d	Sort product with highest price.	Yes	Yes
e	Sort product with relevance.	Yes	Yes
f	Sort product with the newest.	Yes	Yes
g	Press “Buy” button to buy product.	Yes	Yes
7	Shopping Cart		
a	Delete order in shopping cart.	Yes	Yes
b	Change quantity product from shopping cart.	Yes	Yes
8	Rating and Comment		
a	Rating and comment on products previously purchased by users.	Yes	Yes
b	Rating and comment on a product that has never been purchased before by users	Yes	Yes
9	Payment Transaction		
a	Using valid voucher code for payment.	Yes	Yes
b	Using invalid voucher code for payment.	Yes	Yes
c	Transfer payment method and enter correct payment code in accordance with notification.	Yes	Yes
d	Transfer payment method and enter incorrect payment code in accordance with notification.	Yes	Yes
e	Transaction done.	Yes	Yes
10	Wishlist		

a	Select product to wishlist.	Yes	Yes
11	Share Product		
a	Share product to Facebook.	Yes	Yes
b	Share product to Twitter.	Yes	Yes
c	Share product to Google+.	Yes	Yes
d	Share product to Pinterest.	No	No
12	Subscribe		
a	Subscribe seller.	No	No
13	Help		
a	Select contact us.	No	No
14	Chat		
a	Chat between seller and buyer.	Yes	Yes
15	Order Tracking		
a	Seller enters the sales receipt number.	Yes	Yes
16	Application Download		
a	Download application for smartphone.	Yes	Yes
17	Seller		
a	Upload photo to sale by seller.	Yes	Yes
b	Import photo from Instagram.	Yes	Yes
c	Import photo from Facebook.	No	No
d	Seller account setting profile.	Yes	Yes
e	Top up electronic balance.	Yes	Yes
f	Cashed seller electronic balance.	Yes	Yes
g	Download electronic balance mutation.	Yes	Yes
18	Logout		
a	Logout user account.	Yes	Yes

According to the result of Functional Correctness and Functional Appropriateness sub characteristic testing on Tokopedia web application, percentage of Functional Correctness and Functional Appropriateness will be determined as follow by the total number of function is 50.

- Functional Correctness Sub Characteristic

$$Yes = \frac{46}{50} x 100\% = 92\%$$
$$No = \frac{4}{50} x 100\% = 8\%$$

- Functional Appropriateness Sub Characteristic

$$Yes = \frac{46}{50}x100\% = 92\%$$
$$No = \frac{4}{50}x100\% = 8\%$$

- Total Functional Correctness and Functional Appropriateness Sub Characteristic

$$FcrtFapp = \frac{Fcrt+Fapp}{TotalSubCharacteristic} = \frac{92\%+92\%}{2} = 92\%$$

Based on calculation above, the result will be compared with Table 3.22. Indicator of Functional Completeness Sub Characteristic. The result is 92% which on level 5 with range 81%-100%. This shows that Tokopedia web applicaton has very good quality in Functional Completeness aspect.

Based on sub characteristic testing result above, Table 4.53. Below is Functional Suitability characteristic testing result on Tokopedia web application.

Table 4.53: Tokopedia Website Testing Result on Functional Suitability Characteristic

No	Sub Characteristic	Actual Result	Level	Predicate
1	Functional Completeness	92.5%	5	Very Good
2	Functional Correctness	92%	5	Very Good
3	Functional Appropriateness	92%	5	Very Good

4.5.1.2 Testing of Performance Efficiency Characteristic

Testing of Performance Efficiency Characteristic is obtained in three sub characteristics, Time Behavior, Resource Utilization and Capacity. Here is the testing result of each sub characteristics in Performance Efficiency characteristic.

1. Time Behavior Sub Characteristic

   Testing of Time Behavior sub characteristic is obtained by calculate the average of response tim of each function application when application running. Testing will be done in three times using First Media Wi-Fi internet connection with average speed connection is 12.46 Mbps. Speed internet access is measured through http://www.speedtest.net/id/. Table 4.54. Below is testing result of Time Behavior sub characteristic on Tokopedia web application.

Table 4.54: Testing Result of Functional Completeness Sub Characteristic on Tokopedia Web Application

No	Test Case	Response Time (second) Testing of-:			Average Time
		1st	2nd	3rd	(second)
1	Input registration data correctly in accoradance with registration terms.	3.47	3.12	3.63	3.41
2	Input registration data incorrectly in accorandce with registration terms.	3.12	3.32	3.45	3.30
3	Input registration data that have already been registered.	3.42	3.72	3.94	3.70
4	Input login data correctly.	4.48	3.72	3.17	3.79
5	Input login data incorrectly.	4.76	3.82	3.31	3.96
6	Login with correct Facebook account.	3.43	3.18	3.57	3.39
7	Login with incorrect Facebook account.	4.21	3.12	4.06	3.80
8	Login with correct Google+ account.	3.01	3.07	3.53	3.20
9	Login with incorrect Google+ account.	5.13	4.52	5.31	4.99
10	Login with correct Yahoo account.	3.25	3.74	3.87	3.62
11	Login with incorrect Yahoo account.	4.65	4.71	3.89	4.42
12	Forgot password when login.	6.42	6.31	6.92	6.55
13	Select one product category, example: Electronic category.	3.22	3.19	3.42	3.28
14	Filter product by shipment. Example: TIKI	2.52	2.90	3.51	2.98
15	Filter combination using available filter that are price range, shipment and location.	3.11	2.71	3.92	3.25
16	Search “iPhone SE”.	2.22	2.65	2.81	2.56
17	Order product by entering stock quantity exceeds to stock provided by seller.	1.81	1.75	2.04	1.87
18	Order product by entering stock quantity according to stock provided by seller.	2.31	2.55	2.78	2.55
19	Sort product with lowest price.	1.32	1.21	1.32	1.28
20	Sort product with highest price.	1.26	1.23	1.22	1.24
21	Sort product with relevance.	1.41	1.56	2.34	1.77
22	Sort product with the newest.	1.76	2.52	2.43	2.24
23	Press “Buy” button to buy product.	5.78	4.13	6.01	5.31
24	Delete order in shopping cart.	2.21	2.54	2.32	2.36
25	Change quantity product from shopping cart.	2.42	1.72	2.18	2.11
26	Rating and comment on products previously purchased	2.64	2.27	3.18	2.70

	by users.				
27	Rating and comment on a product that has never been purchased before by the user.	2.32	2.83	2.45	2.53
28	Using valid voucher code for payment.ount.	5.15	5.27	5.41	5.28
29	Using invalid voucher code for payment.	4.14	4.65	5.76	4.85
30	Transfer payment method and enter correct payment code in accordance with notification.	6.56	6.43	6.81	6.60
31	Transfer payment method and enter incorrect payment code in accordance with notification.	7.51	7.43	7.68	7.54
32	Transaction done.	3.12	3.54	3.86	3.51
33	Select product to wishlist.	2.21	2.71	2.66	2.53
34	Share product to Facebook.	6.32	6.11	6.37	6.27
35	Share product to Twitter.	7.13	7.76	6.32	7.07
36	Share product to Google+.	5.31	5.42	5.15	5.29
37	Share product to Pinterest.	-	-	-	-
38	Subscribe seller.	-	-	-	-
39	Select contact us.	4.12	4.56	4.81	4.50
40	Chat between seller and buyer.	1.01	1.12	1.03	1.05
41	Seller enters the sales receipt number.	3.44	3.17	3.27	3.29
42	Download application for smartphone.	7.88	6.92	6.96	7.25
43	Upload photo to sale by seller.	3.21	3.66	3.81	3.56
44	Import photo from Instagram.	7.88	7.13	8.03	7.68
45	Import photo from Facebook.	-	-	-	-
46	Seller account setting profile.	2.31	2.51	2.77	2.53
47	Top up electronic balance.	8.12	8.35	8.24	8.24
48	Cashed seller electronic balance.	10.21	10.36	10.74	10.44
49	Download electronic balance mutation.	2.41	2.65	2.17	2.41
50	Logout user account.	3.24	3.04	3.42	3.23
Average		3.98	3.93	4.17	4.03

Testing result of Time Behavior sub characteristic has 4.03 seconds of average response time. This result is compared with Table 3.24. Indicator of Time Behavior Sub Characteristic which measure user satisfaction [10]. Once compared, the result is at level 4 which predicate is “Satisfied” with range of 3-9 seconds. This shows that Tokopedia web application has good quality in Time Behavior sub characteristic.

2. Resource Utilization Sub Characteristic

   Testing of Resource Utilization sub characteristic is obtained by observe the processing of resources when application is running. The resource is the use of memory when application is accessed and surfing the website. Table 4.55. Below is testing result on resource utilization sub characteristic on Tokopedia web application.

Table 4.55: Tokopedia Website Testing Result on Resource Utilization Sub Characteristic

Testing of-	With Cache (MB)	Without Cache (MB)
1st	199,500	163,276
2nd	185,888	183,944
3rd	199,748	179,388
Average	195,045	175,536

Based on Table 4.55. Above, the result will be compared with Table 3.26. Indicator of Resource Utilization sub characteristic. The result is at level 1 with “Very Bad” predicate that shows Tokopedia web application in the use of memory is very good.

3. Capacity Sub Characteristic

   Testing of Capacity sub characteristic is obtained by testing the limit maximum of Tokopedia web application when using. Table 4.56. below is the testing result of Capacity sub characteristic on Bukalapak web application.

Table 4.56: Tokopedia Website Testing Result on Capacity Sub Characteristic

No	Test Case	Actual Case	Actual Result
1	Input product into wishlist more than 100 products.	Input 150 different products into wishlist.	Success.
2	Input more than 100 products into shopping cart.	Input 150 different products into shopping cart.	Success.
3	Add more than 100 favorite stores to favorite stores menu.	Makes 150 favorite stores.	Success.

Based on Table 4.56. Above, the result will be compared with Table 3.27. Indicator of Capacity sub characteristic. The result is Bukalapak web application is at level 5 that “All test cases match the expected result” to show that the application has high capacity.

Table 4.57. Below is the summary of Tokopedia testing result on Performance Effieciency characteristic.

Table 4.57: Tokopedia Website Testing Result on Performance Efficiency Characteristic

No	Sub Characteristic	Actual Result	Level	Predicate
1	Time Behavior	4.03 second	4	Satisfied
2	Resource Utilization	195,045 With Cache	1	Very Bad
		175,536 Without Cache		
3	Capacity	All test cases match the expected result.	5	Very High Capacity

4.5.1.3 Testing of Compatibility Characteristic

Testing of Compatibility characteristic is done by testing its two sub characteristics, Co-Existence and Interoperability. Here is the testing result of each sub characteristic in Compatibility characteristic.

1. Co-Existence Sub Characteristic

   Testing of Co-Existence sub characteristic is done by accessing Tokopedia web application on several browsers using desktop, netbook and notebook through http://www.tokopedia.com (not redirecting to m.tokopedia.com). Table 4.58. Below is the testing result of Co-Existence sub characteristic on Tokopedia web application.

   Table 4.58: Testing Result of Functional Completeness Sub Characteristic on Tokopedia Web Application

No	Test Case	Device Specification	Actual Result
1	Tokopedia sites are accessed using Google Chrome browser.	Desktop	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
2	Tokopedia sites are accessed using Google Chrome browser.	Netbook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
3	Tokopedia sites are accessed using Google Chrome browser.	Notebook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
4	Tokopedia sites are accessed using Internet Explorer browser.	Desktop	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.

5	Tokopedia sites are accessed using Internet Explorer browser.	Netbook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
6	Tokopedia sites are accessed using Internet Explorer browser.	Notebook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
7	Tokopedia sites are accessed using Safari browser.	Desktop	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
8	Tokopedia sites are accessed using Safari browser.	Netbook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
9	Tokopedia sites are accessed using Safari browser.	Notebook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
10	Tokopedia sites are accessed using Mozilla Firefox browser.	Desktop	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
11	Tokopedia sites are accessed using Mozilla Firefox browser.	Netbook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
12	Tokopedia sites are accessed using Mozilla Firefox browser.	Notebook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
13	Tokopedia sites are accessed using Opera browser.	Desktop	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
14	Tokopedia sites are accessed using Opera browser.	Netbook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.
15	Tokopedia sites are accessed using Opera browser.	Notebook	Tokopedia sites running well (no features could not run) and not redirected to m.tokopedia.com.

Based on Table 4.58. Above, the results will be compared with Table 3.28. Indicator of Co-Existence sub characteristic. The result is “All test cases match the expected result” at level 5. This shows Tokopedia web

application is very good on Co-Existence.

2. Interoperability Sub Characteristic

   Testing of Interoperability sub characteristic is done by observing the Bukalapak web application to sharing information with other system. Table 4.59. below is the testing result of Interoperability sub characteristic on Tokopedia web application.

Table 4.59: Tokopedia Website Testing Result on Interoperability Sub Characteristic

No	Test Case	Actual Result
1	Sign up with Google account.	Registered data is according to the connected Google account.
2	Sign up with Facebook account.	Registered data is according to the connected Facebook account.
3	Sign up with Yahoo account.	Bukalapak does not provide Sign up with Yahoo account.
4	Login with Google account.	Login data is according to the connected Google account.
5	Login with Facebook account.	Login data is according to the connected Facebook account.
6	Login with Yahoo account.	Login data is according to the connected Yahoo account.
7	Login with Email account.	Login data is according to the connected email account.
8	Payment with virtual account number.	Payment transaction success and automatically confirmed.
9	Share product to Facebook.	Product shared by users shows on Facebook's user home page.
10	Share product to Twitter.	Product shared by users shows on Twitter's user home page.
11	Share product to Google+.	Product shared by users shows on Google+'s user home page.
12	Share product to Pinterest.	Product shared by users shows on Pinterest's user home page.
13	Share product to Instagram.	Product shared by users shows on Instagram's user home page.
14	Share product to Blogger.	Product shared by users shows on Blogger's user home page.
15	Order Tracking.	Tokopedia provides delivery status information of products purchased by the user.

Based on Table 4.59. above, the testing result will be compared with Table 3.29. Indicator of Interoperability sub characteristic. The testing result is Bukalapak web application at level 5 that "All test cases match with the expected result" to shows that Interoperability is very good.

Table 4.60. below is the summary of Compatibility sub characteristic testing result on Tokopedia web application.

Table 4.60: Tokopedia Website Testing Result on Compatibility Characteristic

No	Sub Characteristic	Actual Result	Level	Predicate
1	Co-Existence	All test cases match the expected result.	5	Very Good
2	Interoperability	There are four test cases do not match the expected result.	5	Very Good

4.5.1.4 Testing of Usability Characteristic

Testing of Usability characteristic on Tokopedia web application consists of six sub characteristics. They are Appropriateness Recognisability, Learnability, Operability, User Error Protection, User Interface Aesthetics, and Accessibility sub characteristic. Testing of Usability characteristic using questionnaire adopted by Lund with 400 respondents. Respondents are with the same criteria of respondents on Bukalapak questionnaire, which is users of both application, Bukalapak and Tokopedia web application. Table 4.61 below is the response from respondents Usability questionnaire for Tokopedia web application.

Table 4.61: Response from Respondents Usability Questionnaire Tokopedia Website

No	Sub Characteristic	Frequency Response Respondents					Mode
		STS	TS	N	S	SS	
1	AR	12	4	52	254	69	S
2	LN1	17	12	60	217	94	S
3	LN2	20	9	49	231	91	S
4	OP1	17	10	52	238	83	S
5	OP2	19	19	81	195	86	S
6	UE1	14	23	151	163	49	S
7	UE2	16	25	177	153	29	S
8	UI1	14	31	78	226	51	S
9	UI2	12	15	76	224	73	S
10	AC1	18	22	132	181	46	S
11	AC2	22	12	75	196	95	S

After having the results on Table 4.61. Above, the calculation scale is calculated with formula that previously described to have feasibility value from Usability characteristic. Table 4.62. below is the calculation of Usability testing result on Tokopedia web application.

Table 4.62: Usability Testing Result of Tokopedia Website

Interpretation	Total (I)	Likert Scale (S)	I x S
STS	182	1	182
TS	182	2	364
N	983	3	2949
S	2278	4	9112
SS	766	5	3830
Total $\sum$ I x S			16347
Maximum Value MaxU			22000

After having feasibility value that shows on Table 4.62. above, then is to do the calculation to get the result testing of Usability characteristic. The calculation is explained on formula below.

$$\frac{\sum IxS}{MaxU} x100\% = \frac{16437}{22000} x\ 100\% = 74.71\%$$

Based on calculation above, the testing result of Usability characteristic is 74,71%. The percentage is compared with Table 3.30. Indicator Usability score interpretation. The testing result of Usability characteristic is at level 4 with range 61% - 80%. Whereas from the mode of response from respondents is "S". It shows that the ability of Tokopedia web application to be used by users is good on Usability criteria.

4.5.1.5 Testing of Reliability Characteristic

Testing of Reliability Characteristic is performed by its four sub characteristics, Maturity, Availability, Fault Tolerance and Recoverability. Here is the detailed of testing result of each sub characteristic in Reliability characteristic on Tokopedia web application.

1. Maturity Sub Characteristic

   Testing of Maturity sub characteristic is obtained by observing which a system, product or component meets needs for reliability under normal operation on Tokopedia web application. Table 4.63. Below is testing result of Maturity sub characteristic on Tokopedia web application.

Table 4.63: Result of Maturity Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result
1	Login with account that does not match with account that has been registered.	Unable to login. User is asked to check the username and password entered.
2	Added 100 products for sale.	Products successfully added.
3	Push promoted for 100 products sales.	Push promoted success.
4	Added 100 products to shopping cart.	Products successfully added to shopping cart.

2. Availability Sub Characteristic

   Testing of Availability sub characteristics aims to see application performance to fulfill needs of user when application used. Table 4.64. Below is test case of Availability sub characteristic.

Table 4.64: Result of Availability Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result
1	Access Tokopedia in Days of National Online Shooping	Tokopedia running normally.
2	Access Tokopedia in Ramadhan Sale Day	Tokopedia running normally.

3. Fault Tolerance Sub Characteristic

   Testing of Fault Tolerance sub characteristic is obtained by ensuring which a system, product or component operates as intended despite the presence of hardware or software faults on Tokopedia web application. Table 4.65. Below is testing result of Fault Tolerance sub characteristic on Tokopedia web application.

Table 4.65: Result of Fault Tolerance Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result
1	Create an account with inappropriate email address 10 times.	Account was not successfully created.
2	Sign up account with incorrect password terms 10 times.	Account was not successfully created.
3	Login with incorrect registered account 10 times.	Unable to login. User is requested to double check the username and password entered whether it is in accordance with the previously registered account.
4	Payment using incorrect virtual account code three times.	Unable to continue the next process.

   Based on Table 4.65. Above, the results will be compared with Table 3.33. Indicator of Fault Tolerance sub characteristic. The result is “All test cases match with the expected result” at level 5. That shows Tokopedia web application is very good on Fault Tolerance aspect.

4. Recoverability Sub Characteristic

   Testing of Recoverability is obtained by observing which, in the event of an interruption or a failure, a product directly affected and re-establish the desired state of the system on Tokopedia web application. Table 4.66. Below is the testing result of Recovery sub characteristic on Tokopedia web application.

Table 4.66: Result of Recoverability Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result
1	Disconnect internet connection when ordering products.	Yes, the ordering process can not be done and Tokopedia provides information to retry the transaction.
2	Enable airplane mode when ordering products.	Yes, the ordering process can not be done and Tokopedia provides information to retry the transaction.
3	Device shut down when ordering product.	Yes, the ordering process can be resumed when the device is on.

Based on Table 4.66. above, the results will be compared with Table 3.34. Indicator of Recoverability sub characteristic. The result is "All test cases match with the expected result" at level 5. That shows Tokopedia web application is very good on Recoverability aspect.

Table 4.67. below is the summary of Reliability characteristic testing result on Tokopedia web application.

Table 4.67: Result of Reliability Characteristic Testing on Tokopedia Web Application

No	Sub Characteristic	Actual Result	Level	Predicate
1	Maturity	All test cases match the expected result	5	Very Good
2	Availability	All test cases match the expected result	5	Very Good
3	Fault Tolerance	All test cases match the expected result.	5	Very Good
4	Recoverability	All test cases match the expected result.	5	Very Good

4.5.1.6 Testing of Security Characteristic

Testing of Security characteristic on Tokopedia web application is performed by its five sub characteristics, Confidentiality, Integrity, Non-Repudiation, Accountability and Authenticity. Here is the detailed of testing result of each sub characteristic in Security characteristic on Tokopedia web application.

1. Confidentiality Sub Characteristic

   Testing of Confidentiality aims to ensure that data are accessible only to those authorized to have access on Tokopedia web application. Table 4.68. below is the testing result of Confidentiality sub caharacteristic on Tokopedia web application.

Table 4.68: Result of Confidentiality Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result	Score Qn
1	Fill registration data with emptying one field.	Display an error message to fill empty field.	1
2	Fill registration data with less than 4 characters.	Display an error message password is too short.	1
3	Fill confirmation password different from the password data to be used.	Display an error message password does not match the confirmation password field.	1
4	Fill registration data with incomplete email address.	Display an error message email does not match.	1
5	Fill registration data using the same email address.	Display an error message email already exists.	1

Based on Table 4.68. above, those scores on testing of Confidentiality characteristic will be calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{confidentiality} = \frac{5}{5} x\ 100\% = 100\%$$

The result obtained of the above formula is 100% at level 5. It shows that the ability Tokopedia web application is accessible only to those authorized to have an access is very high.

2. Integrity Sub Characteristic

Testing of Integrity sub characteristic aims to ensure Tokopedia web application is able to prevent unauthorized access rights into the system. Table 4.69. Below is the result of Integrity sub characteristic testing on Tokopedia web application.

Table 4.69: Result of Integrity Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result	Score Qn
1	Fill login data: a. Incorrect username. b. Correct password.	Displays an error message to check the username and password entered.	1
2	Fill login data: a. Correct username. b. Inorrect password.	Displays an error message to check the username and password entered.	1
3	Reset Password	Sends a password reset message to email.	1
4	Login using Facebook account.	Displays a verification message to sign in with a connected Facebook account.	1
5	Login using Google+ account.	Displays a verification message to sign in with a connected Google+ account.	1
6	Login using Yahoo account.	Displays a verification message to sign in with a connected Yahoo account.	1

Based on Table 4.69. above, those scores on testing of Confidentiality characteristic will be calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{integrity} = \frac{6}{6} x\ 100\% = 100\%$$

The result obtained of the above formula is 100% at level 5. It shows that the ability of Tokopedia web application to prevent unauthorized access rights into the system is very high.

3. Non-Repudiation Sub Characteristic

   Testing of Non-repudiation sub characteristic aims to ensure Tokopedia web application which actions or events cannot be repudiated later. Table 4.70. Below is the result of Non-repudiation sub characteristic testing on Tokopedia web application.

Table 4.70: Result of Non-Repudiation Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result	Score Qn
1	Register through application site	Tokopedia provides proof of registration by email.	1
2	Order product	Tokopedia provides proof of order by email or SMS.	1
3	Payment confirmation	Tokopedia provides proof of payment confirmation by email or SMS.	1
4	Cancellation order.	Tokopedia does not provide proof of cancellation order by email or SMS.	0
5	Product received.	Tokopedia provides proof of product received	1
		by email or SMS.	

Based on Table 4.70. above, those scores on testing of Non-repudiation characteristic will be calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{non-repudiation} = \frac{4}{5}x\ 100\% = 80\%$$

The result obtained of the above formula is 80% at level 4. It shows that the ability of Tokopedia web application to provide proof of every access and transaction is High.

4. Accountability Sub Characteristic

Testing of Accountability sub characteristic aims to ensure Tokopedia web application is able to trace all activities of user. Table 4.71. Below is the result of Accountability sub characteristic testing on Tokopedia web application.

Table 4.71: Result of Accountability Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result	Score Qn
1	View order transaction	Tokopedia provides information of ordered product and current transaction.	1
2	View purchase transaction	Tokopedia provides information of purchased product and current transaction.	1
3	View payment transaction	Tokopedia provides information of current payment transaction status.	1
4	View transaction of received product	Tokopedia provides history of receipt purchased products.	1
5	View wishlist history	Tokopedia provides history of wishlist's user.	1
6	Search history	Tokopedia provides history of searched products.	1
7	Product discussion history	Tokopedia provides history of product discussion by user.	1
8	Chat history.	Tokopedia provides the conversation history between seller and buyer through chat application.	1

Based on Table 4.71. Above, testing result of Accountability sub characteristic is calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{accountability} = \frac{8}{8} x\ 100\% = 100\%$$

The result obtained from Accountability sub characteristic is 100% at level 5. It shows that the ability of Tokopedia web application in tracking activities by users is very high.

5. Authenticity Sub Characteristic

Testing of Authenticity sub characteristic aims to ensure which the identity of a subject or resource can be proved to be the one claimed on Tokopedia web application. Table 4.72. Below is the testing result of Authenticity sub characteristic on Tokopedia web application based on test cases that have been tested.

Table 4.72: Result of Authenticity Sub Characteristic Testing on Tokopedia Web Application

No	Test Case	Actual Result	Score Qn
1	Registration.	Tokopedia sends data verification through email.	1
2	Change password.	Change password success.	1
3	Update account.	Account updated.	1
4	Login in several browsers using different devices without logout first.	Tokopedia does not provides information through email that account that entered is logged in on another device.	0

Based on Table 4.72. Above, testing result of Authenticity sub characteristic is calculated with Goal-Question-Metrics (GQM) as formula below.

$$SS_{authenticity} = \frac{3}{4} x\ 100\% = 75\%$$

Testing result of Authenticity sub characteristic is 75% and at level 4. That shows Tokopedia web application is high to identity of a subject or resource which can be proved to be the one claimed.

Table 4.73. Below is the summary of Security characteristic testing result on Tokopedia web application.

Table 4.73: Result of Security Characteristic Testing on Tokopedia Web Application

No	Sub Characteristic	Result	Level	Predicate
1	Confidentiality	100%	5	The prototype ensures that data are accessible only to those authorized to have access is Very High.
2	Integrity	100%	5	Ability of application to prevent unauthorized access is Very High.
3	Non-Repudiation	80%	4	Ability of the application to provide evidence against the action/ transaction that has been done is High.
4	Accountability	100%	5	Ability of application to track activities of user is Very High.
5	Authenticity	100%	4	Ability of application to provide confirmation the authenticity of user data is High.

4.5.2 Testing of Characteristic in Quality in Use Dimension

Quality in Use dimension has five characteristics and nine sub characteristics that are Effectiveness, Efficiency, Usefulness, Trust, Pleasure, Comfort, Environment Risk Mitigation, Health & Safety Risk Mitigation and Content Completeness. The characteristic testing on Quality in Use dimension is done with similar method with the testing of Usability characteristic, based on

user's perspective through the questionnaire. The questionnaire was adopted by Lund A.R. with 400 respondents. The respondents have the same criteria with Usability questionnaire. Table 4.74. below is the result of response from respondents Quality in Use dimension on Tokopedia website.

Table 4.74: Response from Respondents Quality in Use Questionnaire Tokopedia Website

No	Sub Characteristic	Frequency Response Respondents					Mode
		STS	TS	N	S	SS	
1	EF1	17	12	59	235	77	S
2	EF2	14	20	72	211	83	S
3	EC1	14	46	166	134	40	N
4	EC2	14	23	93	177	93	S
5	US1	17	25	155	160	43	N
6	US2	14	16	132	186	52	S
7	TR1	22	24	83	221	48	S
8	TR2	20	10	84	237	49	S
9	PL1	12	24	132	193	38	S
10	PL2	15	14	111	221	39	S
11	CM1	13	20	137	189	41	S
12	CM2	15	11	80	239	55	S
13	ER	23	76	122	137	42	S
14	HS	16	63	124	150	47	S
15	EN	18	34	187	137	24	N
16	CC	15	28	172	157	28	N
17	FL	20	12	67	247	54	S

After having the results on Table 4.74. Above, the calculation scale is calculated using formula that previously described to have feasibility value from Quality in Use dimension. Table 4.75. below is the calculation of Quality in Use testing result on Tokopedia web application.

Table 4.75: Quality in Use Testing Result of Tokopedia Website

Interpretation	Total (I)	Likert Scale (S)	I x S
STS	279	1	279
TS	458	2	916
N	1976	3	5928
S	3231	4	12924
SS	853	5	4265
Total $\sum$ I x S			24312
Maximum Value MaxU			34000

After having the feasibility value on Table 4.75. Above, then do the calcu-

lation to have the testing results of Usability characteristic. The calculation is described as formula below.

$$\frac{\sum IxS}{MaxU} x\ 100\% = \frac{24312}{34000} x 100\% = 71.51\%$$

Based on calculation above, the testing result of Quality in Use dimension is 71.51%. The percentage is compared with Table 3.30. Score Interpretation. The result is at level 4 with range range 61% - 80%. Whereas from mode of table response from respondents is “S”. It shows that the ability of Tokopedia web application to be used by users in the criteria of effectivity, efficiency, satisfaction, freedom from risk and context completeness is Good.

4.5.3 Testing Result of Tokopedia Web Application Quality (www.tokopedia.com)

The calculation of value of each characteristic and sub characteristic ISO 25010 Quality Model on Product Quality and Quality in Use dimension has been successfully done on both E-Commerce application, Bukalapak and Tokopedia web application. Then the value of sub characteristic of observation result or questionnaire is indicated by indicator level, the value of level is calculated by sub characteristic weight to see whether the result of calculaatin is equal to weight or lower than weight. Table 4.76. Below is the testing result of Product Quality dimension on Tokopedia web application.

Table 4.76: Testing Result of Product Quality Dimension on Tokopedia Web Application

Characteristic	Characteristic Weighted Value	Sub Characteristic	Sub Characteristic Weighted Value (Wn)	Level (Ln)	Sub Characteristic Value (ValueSCn)	Characteristic Value (ValueCn)
Functional Suitability	21.4%	Functional Completeness	1.18%	5	1.18%	21.4%
		Functional Correctness	6.21%	5	6.21%	
		Functional Appropriaten	14.02%	5	14.02%	
Performance Efficiency	25.3%	Time Behavior	16.12%	4	12.90%	16.87%
		Resource	6.53%	1	1.31%	

		Utilization				
		Capacity	2.66%	5	2.66%	
Compatibility	9.7%	Co-Existence	1.62%	5	1.62%	9.7%
		Interoperability	8.08%	5	8.08%	
Usability	15.4%	Appropriateness Recognizability	0.86%	4	0.69%	12.32%
		Learnabiilty	3.93%	4	3.14%	
		Operability	2.51%	4	2.01%	
		User Error Protection	2.09%	4	1.67%	
		User Interface Aesthetics	2.09%	4	1.67%	
		Accessibility	3.93%	4	3.14%	
Reliability	12.8%	Maturity	1.24%	5	1.24%	12.8%
		Availability	2.68%	5	2.68%	
		Fault Tolerance	0.65%	5	0.65%	
		Recoverability	8.23%	5	8.23%	
Security	15.4%	Confidentiality	4.91%	5	4.91%	14.55%
		Integrity	4.99%	5	4.99%	
		Non-Repudiation	1.46%	4	1.17%	
		Accountability	1.29%	5	1.29%	
		Authenticity	2.74%	4	2.19%	
Total Weight	100%	Product Quality Result				87.64%

Table 4.76. Above shows that the quality of Tokopedia web application on Product Quality dimension is 87.64%. The results sho that the quality of Tokopedia web application 22.36% below the maximum weight of E-Commerce application. Overall the quality of Tokopedia web application is at level 4. It shows that the quality of Tokopedia web application is Good on Product Quality dimension.

Furhermore, the testing of Quality in Use dimension is using questionnaire. This is because the Quality in Use dimension is the quality of application that measure by user's perspective. Table 4.77. Below is the testing result of Quality in Use dimension on Tokopedia web application.

Table 4.77: Testing Result of Product Quality Dimension on Tokopedia Web Application

Characteristic	Characteristic Weighted Value	Sub Characteristic	Sub Characteristic Weighted Value (Wn)	Level (Ln)	Sub Characteristic Value (ValueSCn)	Characteristic Value (ValueCn)
Effectiveness	18.6%	Effectiveness	18.6%	4	14.88%	14.88%
Efficiency	16.0%	Efficiency	16.0%	4	12.80%	12.80%
Satisfaction	14.8%	Usefulness	4.01%	4	3.21%	11.86%
		Trust	8.05%	4	6.44%	
		Pleasure	0.95%	4	0.76%	
		Comfort	1.81%	4	1.45%	
Freedom from Risk	13.0%	Economic Risk Mitigation	8.28%	4	6.62%	10.4%
		Environmental Risk Mitigation	1.37%	4	1.10%	
		Health and Safety Risk Mitigation	2.09%	4	2.68%	
Context Coverage	37.6%	Context Completeness	32.9%	4	26.32%	30.08%
		Flexibility	4.7%	4	3.76%	
Total Weight	100%	Quality in Use Result				80.02%

Table 4.77. Above shows that the quality of Tokopedia web application on Quality in Use dimension is 80.02%. The result is indicated that the quality of Tokopedia web application is 19.98% below of maximum weight Quality in Use dimension of E-Commerce application. Overall the quality of Tokopedia web application is at level 4. It shows that the quality of Tokopedia web application is good on Quality in Use dimension by user's perspective.

Furthermore, researcher will describe the testing quality of each sub characteristic using priority table. This is to ensure whether the criteria on Tokopedia web application fulfill the characteristic qualiy with weighting based on priority ranking of Product Quality and Quality in Use. Table 4.78. Below is the priority ranking result of Product Quality dimension on Tokopedia web application.

Table 4.78: Priority Ranking Result of Product Quality Dimension on Tokopedia Web Application

No	Sub Charactertistic	Ranking	Relative Weight	Result
2.1.	Time Behavior	1	16.12%	12.90%
1.3.	Functional Appropriateness	2	14.02%	14.02%
5.4.	Recoverability	3	8.23%	8.23%
3.2.	Interoperability	4	8.08%	4.85%
2.2.	Resource Utilization	5	6.53%	6.53%
1.2.	Functional Correctness	6	6.21%	6.21%
3.2.	Confidentiality	7	4.91%	4.91%
3.1.	Integrity	8	4.99%	4.99%
4.2.	Learnabilty	9	3.93%	3.14%
4.6.	Accessibility	10	3.93%	3.14%
3.3.	Authenticity	11	2.74%	2.74%
5.2.	Avalability	12	2.68%	2.68%
2.3.	Capacity	13	2.66%	2.66%
4.3.	Operability	14	2.51%	2.01%
4.4.	User Error Protection	15	2.09%	1.67%
4.5.	User Interface Aesthetics	16	2.09%	1.67%
3.1.	Co-Existence	17	1.62%	1.62%
3.4.	Non-Repudiation	18	1.46%	1.17%
3.5.	Accountability	19	1.29%	1.29%
5.1.	Maturity	20	1.24%	1.24%
1.1.	Functional Completeness	21	1.18%	1.18%
4.1.	Appropriateness Recognizability	22	0.86%	0.69%
5.3.	Fault Tolerance	23	0.65%	0.65%
5.3.	Total Weight		100%	87.64%

Table 4.78 Above shows that Tokopedia web application has met the most important characteristic criteria tha must be required with the percentage of quality of each sub characteristic in accordance with the appropriate percentage. While the priority ranking of sub characteristic in Quality in Use dimension can be seen in Table 4.79. Below.

Table 4.79: Priority Ranking Result of Quality in Use Dimension on Tokopedia Web Application

No	Sub Charactertistic	Ranking	Relative Weight	Result
2.1.	Context Completeness	1	32.9%	26.32%
1.3.	Effectiveness	2	18.6%	14.88%
5.4.	Efficiency	3	16.0%	12.80%
3.2.	Trust	4	8.05%	6.44%
2.2.	Economic Risk Mitigation	5	8.28%	6.62%
1.2.	Flexibility	6	4.70%	3.76%
3.2.	Usefulness	7	4.01%	3.21%
3.1.	Health and Safety Risk Mitigation	8	3.35%	2.68%
4.2.	Comfort	9	1.81%	1.45%
4.6.	Environmental Risk Mitigation	10	1.37%	1.10%
3.3.	Pleasure	11	0.95%	0.76%
5.3.	Total Weight		100%	80.02%

Table 4.79. Above shows that Tokopedia web application is able to meet the most important criteria required by the percentage of quality of each sub characteristic generates a number that is not too far from the appropriate percentage.

4.6 Quality Comparison of Bukalapak and Tokopedia Web Application

Quality of Bukalapak and Tokopedia web application have got the percentage result through the previously testing. Table 4.80. below is the quality testing result of Bukalapak and Tokopedia web application using ISO 25010 Quality Model.

Table 4.80: Quality Testing Result of Bukalapak and Tokopedia Web Application Using ISO 25010 Quality Model

Application	Dimension		Total Quality Application	Maximum Quality
	Product Quality	Quality in Use		
Bukalapak	90.18%	80.02%	85.10%	100%
Tokopedia	87.64%	80.02%	83.83%	100%

The result on Table 4.80. Above also can be seen through the graphic on Figure 4.23. Below.

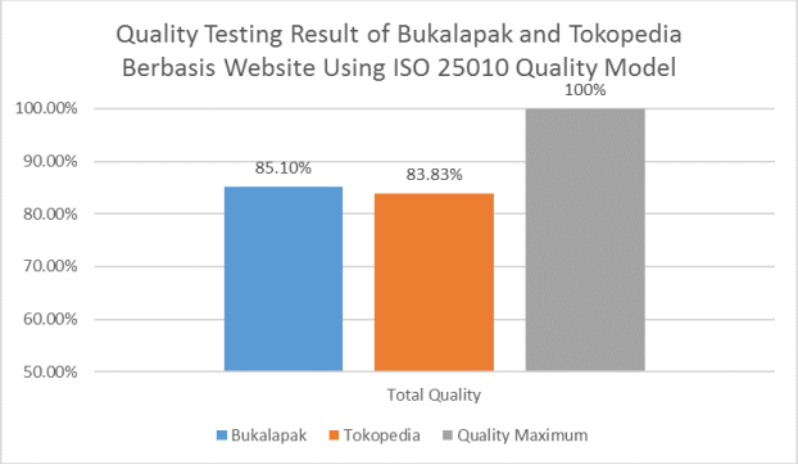


Figure 4.23: Quality Comparison of Bukalapak and Tokopedia Web Application

Figure 4.23.Above shows that Bukalapak web application has a superior quality compared to Tokopedia web application. From all quality of application, Bukalapak has quality value of 85.10% and Tokopedia of 83.83%. Bukalapak web application is superior to 1.27% compared to Tokopedia web application. But both application have been able too meet the needs of users, viewed by percentage of application quality is not too far from the maximum total maximum quality of E-Commerce application.

Chapter 5

CONCLUSION AND FUTURE WORKS

5.1 Conclusion

The quality measurement of Bukalapak and Tokopedia web application using ISO 25010 Quality Model has been successfully done with predetermined methods. Overall, both E-Commerce applications that are part of the top five brands in Indonesia according to research of PT. Nusa Research in 2015 was obtained good quality with value above 80%. The quality value of the application is related by its weight and sub characteristic value. Ordering of weight on each characteristic and sub characteristic in ISO 25010 Quality Model result from questionnaires distributed by 30 responders who have experience using E-commerce application based on website and have background in technology field, be it developer or application user with Bachelor Degree Computer and Bachelor of Engineering with Analytical Hierarchy Process (AHP) method. Respondent data is then processed using BPMSG AHP Priority Calculator tool with Consistency Ratio (CR) <10, so that the weighting result can be accessed accurately and reliably. The value of Bukalapak's total application quality is 85.10% and Tokopedia 83.83%. The Bukalapak web application is superior to 1.27% of Tokopedia web application. The advantage possessed by the percentage of Bukalapak web application quality value is superior to 2.54% from Product Quality dimension of 90.18%. The Bukalapak web application has a higher quality value on sub characteristic of Authenticity and Resource Utilization. This shows that the quality of Bukalapak web application is superior to the Tokopedia web application. The percentage of application quality of Bukalapak and

Tokopedia web application from Quality dimension in use is the same that is 80.02% which is at level 4 with good quality predicate. Overall, the quality of both applications of Bukalapak and Tokopedia are good and able to help fulfill user needs in doing business transactions online.

5.2 Future Works

The quality measurement of Bukalapak and Tokopedia web application using ISO 25010 Quality Model is open for development. Measurement of the quality of Bukalapak and Tokopedia web application needs to be done with different types of testing that are more amenable and use tools for some characteristics in Product Quality dimension, so that more detailed and accurate results are obtained. In addition, the data collection is also needs from internal parties and the distribution of questionnaires on the Usability characteristic and Quality in Use dimension can be done evenly throughout the territory of Indonesia.

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APPENDIX

Appendix 1. Questionnaires of Usability and Quality in Use Aspect

Pengukuran Kualitas Aplikasi E-Commerce Berbasis Website www.Bukalapak.com dan www.Tokopedia.com

Assalamualaikum Wr. Wb.

Sehubungan dengan adanya penelitian yang sedang saya lakukan mengenai pengukuran kualitas aplikasi E-Commerce berbasis website di Jakarta, Bogor, Depok, Tangerang dan Bekasi (studi kasus: www.bukalapak.com dan www.tokopedia.com).
Adapun penelitian ini dibuat untuk menyelesaikan Tugas Akhir.

Bersama ini saya:

Nama : Amanda Terrena Putri, S.Kom
Jurusan : Magister Sistem Informasi Bisnis, Universitas Gunadarma

Dengan segala kerendahan hati, saya memohon bantuan Anda sebagai pengguna aplikasi E-Commerce untuk mengisi kuesioner ini. Aplikasi E-COMMERCE merupakan aplikasi untuk bertransaksi bisnis (jual dan beli barang) secara online. Jawaban yang Anda berikan semua adalah benar. Pastikan tidak ada jawaban yang terlewat. Kerahasiaan atas data dan jawaban Anda akan dijamin oleh peneliti. Atas ketersediaan Anda, saya ucapkan terima kasih.

Hormat saya,

Peneliti
(Amanda Terrena Putri, S.Kom)

* Wajib

IDENTITAS RESPONDEN

Data diri yang Anda berikan akan kami jaga kerahasiaannya dengan baik.

Nama Lengkap (Inisial) *

Jawaban Anda

Jenis Kelamin *

- ◯ Pria
- ◯ Wanita

Usia (tahun) *

Jawaban Anda

Pendidikan Terakhir *

- ◯ SMA/ SMK/ Sederajat
- ◯ D3
- ◯ S1
- ◯ S2
- ◯ S3

Pekerjaan *

- ◯ Mahasiswa/i
- ◯ Guru/ Dosen
- ◯ Pegawai Swasta/ Negeri
- ◯ Wiraswasta
- ◯ Lainnya

Kabupaten/ Kota Domisili Saat Ini *
(Misal: Jakarta Timur)

Jawaban Anda

Nomor Handphone (Optional)
(Apabila Anda beruntung, Anda akan mendapatkan voucher pulsa)

Jawaban Anda

Browser yang Anda gunakan untuk membuka aplikasi *

Pilih

Keterkaitan Anda terhadap aplikasi *

- ◯ Penjual
- ◯ Pembeli (Pengguna saja)
- ◯ Keduanya (Penjual dan Pembeli)

BERIKUTNYA

Jangan pernah mengirimkan sandi melalui Google Formulir.

Pengukuran Kualitas Aplikasi E-Commerce Berbasis Website www.Bukalapak.com dan www.Tokopedia.com

* Wajib

Kualitas Aplikasi E-Commerce

Pernyataan-pernyataan di bawah ini berkaitan dengan persepsi Anda terhadap kualitas aplikasi E-Commerce berbasis website yaitu Bukalapak (www.bukalapak.com) dan Tokopedia (www.tokopedia.com).
Berikut adalah skala pada setiap pernyataan kuesioner ini.

STS = Sangat Tidak Setuju
TS = Tidak Setuju
N = Netral
S = Setuju
SS = Sangat Setuju

Saya merasa aplikasi sesuai dengan kebutuhan saya *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya mempelajari cara menggunakan aplikasi dengan cepat *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi mudah untuk dipelajari *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi mudah untuk digunakan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi membutuhkan langkah yang singkat ketika digunakan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi memberikan pencegahan terhadap kesalahan yang saya lakukan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi memberikan pemulihan terhadap kesalahan yang saya lakukan *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa tampilan aplikasi konsisten *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa tampilan aplikasi user friendly *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa aplikasi dapat digunakan dalam berbagai kondisi tertentu *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa aplikasi ini dapat digunakan oleh pengguna dengan jangkauan yang luas *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi membantu pencapaian tujuan saya dengan lebih mudah *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi membantu saya menjadi lebih efektif *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi membantu saya menjadi lebih produktif *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi memberikan kepercayaan untuk dapat digunakan sesuai dengan kebutuhan saya sebagaimana fungsinya *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi menyenangkan untuk digunakan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi memberikan kepuasan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi adalah yang saya butuhkan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi menghemat waktu saya ketika digunakan *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa aplikasi memberikan dampak positif terhadap saya *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa aplikasi memberikan manfaat terhadap diri saya *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa aplikasi dapat memenuhi apa yang saya inginkan *

	STS	TS	N	S	SS
Bukalapak	◯	◯	◯	◯	◯
Tokopedia	◯	◯	◯	◯	◯

Saya merasa aplikasi nyaman untuk digunakan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi membuat saya menjadi lebih hemat *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi dapat mengurangi risiko kejahatan pada diri saya *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi mengurangi perangkat yang berdampak pada lingkungan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi memberikan kelengkapan komponen *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Saya merasa aplikasi fleksibel untuk digunakan *

	STS	TS	N	S	SS
Bukalapak	○	○	○	○	○
Tokopedia	○	○	○	○	○

Diantara kedua Aplikasi tersebut, manakah yang paling Anda sukai (yang paling sering Anda gunakan)? Bukalapak atau Tokopedia? Berikan alasan singkat *

Jawaban Anda

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